



Aeronautical
Engineering
A Continuing
Bibliography
with Indexes

NASA SP-7037(187)
May 1985

National Aeronautics and
Space Administration



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Administration) 200 p HC A09

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SPECIAL NOTICE ENCLOSED
NEW FOREIGN TECHNOLOGY INDEX INCLUDED IN THIS ISSUE

ACCESSION NUMBER RANGES

Accession numbers cited in this Supplement fall within the following ranges.

STAR (N-10000 Series)	N85-15657 - N85-17931
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IAA (A-10000 Series)	A85-19102 - A85-22566
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SPECIAL NOTICE

FOREIGN TECHNOLOGY INDEX IN THIS ISSUE

Documents referred to in this bibliography whose country of intellectual origin is other than the United States are listed in the Foreign Technology Index (see page D-1).

A great deal of excellent scientific and technical work is done throughout the world. To the extent that U.S. researchers, engineers, and industry can utilize what is done in foreign countries, we save our resources. We can thus increase our country's productivity.

We are testing out this approach by helping readers bring foreign technology into focus. We would like to know whether it is useful, and how it might be improved.

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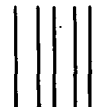
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AERONAUTICAL ENGINEERING

A CONTINUING BIBLIOGRAPHY WITH INDEXES

(Supplement 187)

A selection of annotated references to unclassified reports and journal articles that were introduced into the NASA scientific and technical information system and announced in April 1985 in

- *Scientific and Technical Aerospace Reports (STAR)*
- *International Aerospace Abstracts (IAA).*



Scientific and Technical Information Branch

1985

National Aeronautics and Space Administration

Washington, DC

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INTRODUCTION

Under the terms of an interagency agreement with the Federal Aviation Administration this publication has been prepared by the National Aeronautics and Space Administration for the joint use of both agencies and the scientific and technical community concerned with the field of aeronautical engineering. The first issue of this bibliography was published in September 1970 and the first supplement in January 1971.

This supplement to *Aeronautical Engineering -- A Continuing Bibliography* (NASA SP-7037) lists 725 reports, journal articles, and other documents originally announced in April 1985 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA)*.

The coverage includes documents on the engineering and theoretical aspects of design, construction, evaluation, testing, operation, and performance of aircraft (including aircraft engines) and associated components, equipment, and systems. It also includes research and development in aerodynamics, aeronautics, and ground support equipment for aeronautical vehicles.

Each entry in the bibliography consists of a standard bibliographic citation accompanied in most cases by an abstract. The listing of the entries is arranged by the first nine *STAR* specific categories and the remaining *STAR* major categories. This arrangement offers the user the most advantageous breakdown for individual objectives. The citations include the original accession numbers from the respective announcement journals. The *IAA* items will precede the *STAR* items within each category.

Seven indexes -- subject, personal author, corporate source, foreign technology, contract number, report number, and accession number -- are included.

An annual cumulative index will be published.

AVAILABILITY OF CITED PUBLICATIONS

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All publications abstracted in this Section are available from the Technical Information Service, American Institute of Aeronautics and Astronautics, Inc. (AIAA), as follows: Paper copies of accessions are available at \$8.50 per document. Microfiche⁽¹⁾ of documents announced in *IAA* are available at the rate of \$4.00 per microfiche on demand. Standing order microfiche are available at the rate of \$1.45 per microfiche for *IAA* source documents.

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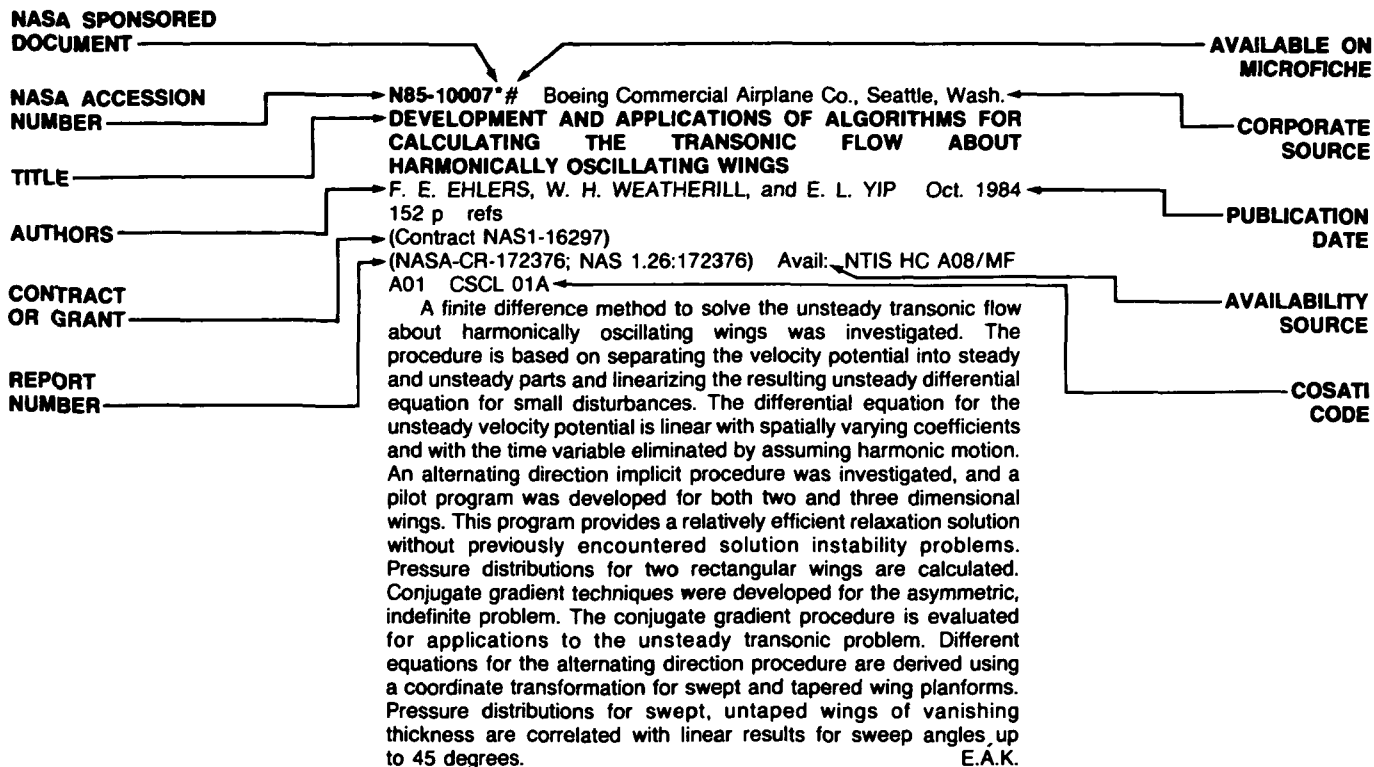
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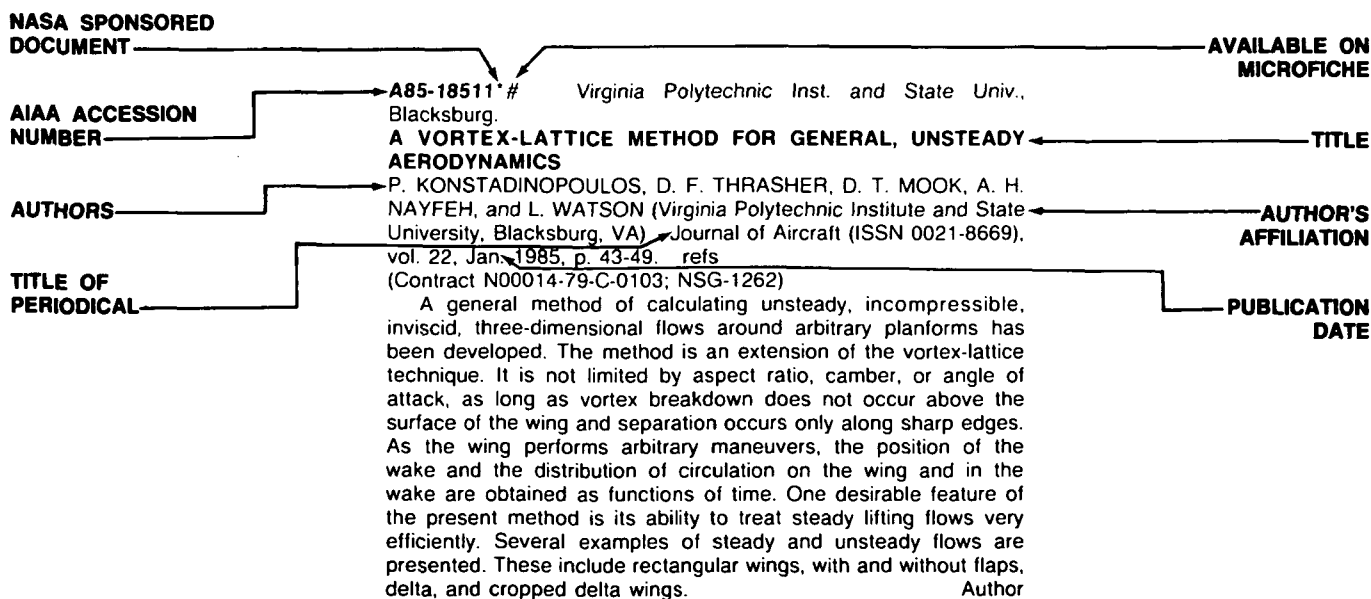
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AERONAUTICAL ENGINEERING

A Continuing Bibliography (Suppl. 187)

MAY 1985

01

AERONAUTICS (GENERAL)

A85-19658*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

CALCULATION OF THE EXCHANGE RATIO FOR THE ADAPTIVE MANEUVERING LOGIC PROGRAM

F. NEUMAN and H. ERZBERGER (NASA, Ames Research Center, Moffett Field, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 9 p.

(AIAA PAPER 85-0311)

Improvements were made to the Adaptive Maneuvering Logic (AML) computer program, a computer-generated, air-to-air combat opponent. The primary improvement was incorporating a measure of performance, the exchange ratio, defined as the statistical measure of number of enemy kills divided by number of friendly losses. This measure was used to test a new modification of the AML's combat tactics. When the new version of the AML competed against the old version, the new version won with an exchange ratio of 1.4.

Author

A85-19812

COMBAT AIRCRAFT: FLIGHT VEHICLES, POWER PLANTS, AND THEIR MAINTENANCE [BOEVAIA AVIATSIONNAIA TEKHNIKA: LETATEL'NYE APPARATY, SILOVYE USTANOVKI I IKH EKSPLOATATSIYA]

V. F. PAVLENKO, A. A. DIACHENKO, V. I. ZHULEV, B. K. KOLPAKOV, A. P. NAZAROV, and V. A. TIKHONRAVOV Moscow, Voennoe Izdatel'stvo, 1984, 320 p. In Russian. refs

The book covers the aerodynamics and flight dynamics of aircraft, the design of combat airplanes and helicopters, aircraft engines, and ground support services. Specific topics discussed include aircraft stability and control, flight characteristics of helicopters, the design of the airframe, take-off and landing gear, hydraulic and pneumatic systems, aircraft control systems, and fuel systems. The main design features, performance characteristics, and limitations of gas-turbine, turbojet, turboramjet, and bypass engines are examined. Attention is also given to maintenance and repair of aircraft, aircraft reliability, and aviation fuels and lubricants.

V.L.

A85-20057

ADVANCED HELICOPTER TECHNOLOGY - INDUSTRY GIRDS FOR CHALLENGES OF EVOLVING OPERATIONAL NEEDS

Aviation Week and Space Technology (ISSN 0005-2175), vol. 122, Jan. 14, 1985, p. 40-43, 45, 46.

Military programs that are setting the pace of technology development for the helicopter industry are the 'JVX' joint services vertical lift aircraft and the U.S. Army's 'LHX' advanced scout/attack/utility helicopter. Much of the powerplant, drivetrain, airframe materials and structures, control system and avionics technologies developed to meet the requirements stipulated by these military programs will be applied to the design of commercial rotorcraft, which are expected to demand lower weights and costs

and higher speeds and efficiencies than are currently available. Day/night, all-weather capabilities for commercial aircraft will also be predicated on military technology developments. Attention is given to multicompany development and construction arrangements, as well as to the requirements of NATO's European nations.

O.C.

A85-20451

CURRENT PROBLEMS IN AVIATION SCIENCE AND TECHNOLOGY [AKTUAL'NYE PROBLEMY AVIATSIONNOI NAUKI I TEKHNIKI]

V. Z. PARTON, ED. Moscow, Izdatel'stvo Mashinostroenie, 1984, 280 p. In Russian. For individual items see A85-20452 to A85-20479.

Various aspects of aircraft structural design are examined. Particular attention is given to the use of plate and shell theory in determining the optimal parameters of aircraft structural elements; the mechanical properties and fracture processes of aircraft construction materials; the fatigue life of metals under multicycle loading; fabrication-related stresses and strains in reinforced plastics; and the properties of composite materials used in aircraft design. The application of CAD systems to aircraft design is considered in detail.

B.J.

A85-20453

COMPUTERS AND PROGRESS IN AVIATION [EVM I PROGRESS AVIATSIU]

S. M. BELOTSEKOVSKIY IN: Current problems in aviation science and technology. Moscow, Izdatel'stvo Mashinostroenie, 1984, p. 15-28. In Russian. refs

The impact of advanced computer technology on aviation is examined. Particular attention is given to the use of computers in the development of: active aircraft control; the anticipatory operation of mathematical models of aircraft; linear aeroelasticity and nonlinear aerodynamics calculations; and identification based on complete a priori information. Examples illustrating the numerical-experiment methodology are given.

B.J.

A85-20455

TRAINING AND RESEARCH CAD SYSTEM OF THE MOSCOW AVIATION INSTITUTE AND EXPERIENCE IN ITS USE [UCHEBNO-ISSLEDOVATEL'SKAIA SAPR MOSKOVSKOGO AVIATSIONNOGO INSTITUTA I OPYT EE PRIMENENIIA]

I. T. BELIAKOV IN: Current problems in aviation science and technology. Moscow, Izdatel'stvo Mashinostroenie, 1984, p. 37-44. In Russian.

The set of problems that were considered and solved in the development of the training and research CAD system of the Moscow Aviation Institute is described. Particular emphasis is placed on the development of a system nucleus which is an invariant software-informational subsystem of the CAD system, providing for the efficient operation of the problem-oriented subsystems. First results in the use of this CAD system in training processes are presented, and the use of this system for aircraft design is examined.

B.J.

01 AERONAUTICS (GENERAL)

A85-20466

SOME PROBLEMS IN THE DEVELOPMENT OF CAD SYSTEMS [O NEKOTORYKH VOPROSAKH RAZRABOTKI SAPR]

I. IA. LANDAU and B. N. NAUMOV IN: Current problems in aviation science and technology Moscow, Izdatel'stvo Mashinostroenie, 1984, p. 142-148. In Russian.

Various problems involved in the development of computer-aided design (CAD) systems are examined using a CAD system for the development of the digital components of minicomputers as an example. The architecture of the CAD system and the tasks it can perform are discussed. In particular, attention is given to the principal functions of the CAD data bank and the software of the technical design subsystem. V.L.

A85-21382

TOOLING PROBLEMS IN THE MANUFACTURE OF AH-64 COMPOSITES FLEXBEAM TAIL ROTOR

R. A. LOFLAND (Hughes Helicopters, Inc., Culver City, CA) IN: Composite structures; Proceedings of the National Specialists' Meeting, Philadelphia, PA, March 23-25, 1983. Washington, DC, American Helicopter Society, 1984, 4 p.

Initial manufacturing efforts for the AH-64 Apache helicopter's Composite Flexbeam Tail Rotor encountered unique tooling and fabrication problems associated with a design configuration that simultaneously required extreme flexibility and torsional strength at the flexbeam pitch-case juncture, where a high strength bond was required to allow blade pitch variation. The thermal expansion of silicon rubber was used as the basis of a process that would generate sufficient external bonding pressures at the juncture, as well as over most of the junction of the pitch cases. O.C.

A85-21394

FABRICATION AND ASSEMBLY OF COMPOSITE REAR FUSELAGE (CRF) TOOLING AND MANUFACTURING FOR THE UH-60 HELICOPTER

D. G. ORLINO (U.S. Army, Applied Technology Laboratory, Fort Eustis, VA) and G. JACARUSO (United Technologies Corp., Sikorsky Aircraft Div., Stratford, CT) IN: Composite structures; Proceedings of the National Specialists' Meeting, Philadelphia, PA, March 23-25, 1983. Washington, DC, American Helicopter Society, 1984, 15 p.

Advanced manufacturing methods have been used to reduce the parts count of a composite rear fuselage assembly for the UH-60 helicopter, which is 38 percent more economical to manufacture and 10 percent lighter than its metallic counterpart. In particular, the method employed to fabricate the steel shell molds for the composite structure proved to be less expensive than state-of-the-art fiberglass/epoxy molds. A practical size limit has been reached in molding the lower rear fuselage skin panels, due to tooling complexities. Precutting, preplying and preforming outside of the molds has proved to be a cost-effective way of handling the thousands of individual plies. The composite structure has passed both static testing to limit and ultimate loading tests. O.C.

A85-21456

DESIGN AND ADVANCED CONCEPTS OF AVIONICS/WEAPONS SYSTEM INTEGRATION; PROCEEDINGS OF THE SYMPOSIUM, LONDON, ENGLAND, APRIL 3, 4, 1984

Symposium sponsored by the Royal Aeronautical Society, London, Royal Aeronautical Society, 1984, 96 p. For individual items see A85-21457 to A85-21467.

Among the topics discussed are software design methods for advanced military avionics, a design methodology for integrated avionics, hardware design techniques, packaging and interconnection practices for avionics, integrated navigation systems, and aspects of the man-machine interface in military aircraft. Also covered are flight-critical phases of the man-machine interface; trends in both digital flight control and digital engine control system designs, and integrated avionics for helicopters. O.C.

A85-21680

ADVANCED TECHNOLOGY - THE KEY TO EUROPEAN COMPETITIVENESS

J. K. W. THOMAS (Airbus Industrie, Blagnac, Haute-Garonne, France) Aeronautical Society of South Africa and South African Institute of Aeronautical Engineers, Journal (ISSN 0250-3786), vol. 5, no. 1, 1984, p. 35-40.

Attention is given to the technology development aspects of the Airbus Industrie consortium's competitiveness as an airliner manufacturer. Efforts in novel technology integration have led to the refinement of the A300 aircraft into its A300-600, A310-300, and A320 variants by incorporating advanced cockpit display and control systems, lateral control improvements (through low speed aileron deletion), weight savings through structural innovations, center-of-gravity control management, fly-by-wire systems, load alleviation control features, and variable camber wing profile control. O.C.

A85-22226#

TRENDS IN CIVIL AIRCRAFT DESIGN

P. SMITH and A. STEPHENSON (British Aerospace, PLC, Aircraft Group, Hatfield, Herts., England) Aeronautical Society of India, Journal (ISSN 0001-9267), vol. 36, May 1984, p. 69-94.

Future trends in fixed-wing aircraft design are forecast in a 17-year timeframe, based on a statistical study of past developments. Among the aspects studied are: safety, environmental considerations, flexibility, fuel efficiency, economics and structures reliability and weight contribution. Furthermore, the benefits of the implementation of Al-Cu and Al-Zn alloys and fiber-reinforced composites are considered with respect to the strength and weight of wing structures. Finally, recent, as well as planned, advances in flight control systems, such as the digital Automatic Flight Control System and fly-by-wire controls, are reviewed. L.T.

N85-15658*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

TEMPERATURE DISTORTION GENERATOR FOR TURBOSHAFT ENGINE TESTING

G. A. KLANN, R. L. BARTH, and T. J. BIESIADNY Dec. 1984 34 p refs Presented at the SAE Aerospace Congr. and Exposition, Long Beach, Calif., 15-18 Oct. 1984

(NASA-TM-83748; USAAVSCOM-TR-84-C-12; E-2197; NAS 1.15:83748) Avail: NTIS HC A03/MF A01 CSCL 01B

The procedures and unique hardware used to conduct an experimental investigation into the response of a small-turboshaft-engine compression system to various hot gas ingestion patterns are presented. The temperature distortion generator described herein uses gaseous hydrogen to create both steady-state and time-variant, or transient, temperature distortion at the engine inlet. The range of transient temperature ramps produced by the distortion generator during the engine tests was from less than 111 deg K/sec (200 deg R/sec) to above 611 deg K/sec (1100 deg R/sec); instantaneous temperatures to 422 deg K (760 deg R) above ambient were generated. The distortion generator was used to document the maximum inlet temperatures and temperature rise rates that the compression system could tolerate before the onset of stall for various circumferential distortions as well as the compressor system response during stall. Author

N85-15659# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Systems and Logistics.

UNITED STATES AIR FORCE AIRCRAFT MODIFICATION PROCESS: A SYSTEM DYNAMICS ANALYSIS M.S. Thesis

R. BAILEY and H. F. STALCUP Sep. 1984 232 p (AD-A146954; AFIT/GSM/LSY/84S-2) Avail: NTIS HC A11/MF A01 CSCL 01C

A conceptual model of the Air Force aircraft modification process was developed and validated in this thesis. The model was designed using the system dynamics technology and is a tool to extend the knowledge and understanding of the decision and policy-makers within the modification process. Sources of

information used in the development of the model included both literature research and personal interviews. The personal interviews were conducted with Air Force, DOD, OMB, and Congressional people active in the aircraft modification process. Five key issues concerning the behavior of the system were identified and detailed. These issues were: the lack of a systems approach to modification management, the absence of a Class IV requirements approval process, the difficulties of management split between AFSC and AFLC, the priority ranking of modifications by the financial community, and the weaknesses of the process which are currently overcome by strong individuals. Five recommendations for change to the modification process were presented. The recommendations were to establish a requirements review, approval, and ranking process for Class IV modifications, encourage a systems approach to management, improve the credibility and understanding of the process, and encourage competition by several means. GRA

N85-15660# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Systems and Logistics.
PERFORMANCE EVALUATION OF A-10 AIRCRAFT MAINTENANCE UNITS AND AIRCRAFT USING CONSTRAINED FACET ANALYSIS M.S. Thesis

V. J. GONNERMAN Sep. 1984 75 p
 (AD-A146955; AFIT/GLM/LSM/84S-26) Avail: NTIS HC A04/MF A01 CSCL 15E

Performance evaluation is required to obtain important feedback on system efficiency for management decision making. For Air Force aircraft maintenance managers, performance evaluation is crucial for determining capability and evaluating unit efficiency and effectiveness. This thesis effort applied Constrained Facet Analysis (CFA), a linear fractional programming technique, to the performance evaluation of aircraft maintenance units (AMUs) and aircraft. Empirical data for three AMUs covering a five month period of time and simulated data for 28 aircraft was evaluated using the CFA and Data Envelopment Analysis (DEA) computer programs at the University of Texas. Results show that CFA and DEA can be used to evaluate relative efficiency of Air Force units. GRA

N85-15661# Naval Ship Research and Development Center, Bethesda, Md.
CIRCULATION CONTROL: A BIBLIOGRAPHY OF DTNSRDC RESEARCH AND SELECTED OUTSIDE REFERENCES: UPDATE Research and Development Report, Jan. 1969 - Dec. 1983
 R. J. ENGLAR and C. A. APPLGATE Sep. 1984 55 p
 (AD-A146966; AERO-1291; DTNSRDC-84/052) Avail: NTIS HC A04/MF A01 CSCL 05B

This report is an update of a previously published bibliography (Report 77-0076) of formal reports, departmental reports, and technical papers by personnel of the Aviation and Surface Effects Dept., David W. Taylor Naval Ship Research and Development Center. Included are publications for the period of January 1969 through December 1983. The citations are arranged chronologically and represent the development of circulation control technology at the Center over the past several years. Selected outside references pertinent to circulation control are presented in the appendix. Originator - supplied keywords include: Circulation control aerodynamics, Blown flaps, Boundary layer control, Bluff airfoils, Critical Mach number, Elliptic airfoils, Finite wing, Helicopter Rotor, Helicopter Rotor Airfoil, High Advance Ratios, High-Lift Systems, Hover Performance, Jet Flaps, Subsonic Wind Tunnel, STOL Aircraft, Tangential Blowing, and V/STOL Aircraft. GRA

N85-15662# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Systems and Logistics.
PARAMETRIC ESTIMATES OF PROPULSION SYSTEM MAINTENANCE MANHOURS M.S. Thesis
 T. J. SHARP Sep. 1984 97 p
 (AD-A147120; AFIT/GLM/LSM/84S-57) Avail: NTIS HC A05/MF A01 CSCL 01C

This thesis investigated the potential of using cost-estimating relationships (CERs) to estimate aircraft maintenance manhour requirements for propulsion systems. The performance

specifications and physical parameters of a large sample of USAF turbine engines were used to develop CERs. These CERs could be applied early in the life cycle of an engine in acquisition in order to estimate future maintenance requirements and effect design configuration changes. The analysis was accomplished by the method of linear regression analysis of least squares. The CERs resulting from the regression were subjected to three tests to determine their predictive capability. A number of the CERs developed in the study displayed sufficient accuracy to be considered for application on acquisition programs. GRA

N85-15663# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Systems and Logistics.
A Q-GERT NETWORK SIMULATION MODEL FOR EXAMINING PIPELINE TIME IN THE NAVY'S J-52 INTERMEDIATE LEVEL JET ENGINE REPAIR CYCLE M.S. Thesis
 M. N. ROMERO Sep. 1984 152 p
 (AD-A147269; AFIT/GLM/LSM/84S-56) Avail: NTIS HC A08/MF A01 CSCL 15E

Recent data suggest that the actual turnaround time (TAT) for the J-52 engine is almost four times the standard specified by the directive. One approach to investigating this excessive time in the pipeline is to examine the operation of the repair system, focussing attention on the utilization of resources. The objective of this project was, therefore, to develop a computer simulation model which replicates the J-52 intermediate level repair cycle, concentrating on repair crews, workstands, and test cells as the major resources employed. A hypothetical scenario based on contrived parameters was developed in order to convert the model to code and demonstrate its application on the computer. The results of a sample simulation show that excessive repair backlogs and delays as well as inefficient resource utilization can, in fact, be identified in the output, thereby paving the way for management to experiment with different resource utilization schemes in order to achieve a lower TAT. GRA

N85-15664# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).
OPERATIONAL LOADS DATA
 Loughton, England Aug. 1984 303 p refs In ENGLISH and FRENCH Conf. held in Sienna, Italy, 2-6 Apr. 1984
 (AGARD-CP-375; ISBN-92-835-0363-5) Avail: NTIS HC A14/MF A01

General principles followed in acquiring data on operational loads sustained by NATO aircraft, both fixed and rotary wing, in normal service were examined. Current and developing loads data acquisition programs were compared. The techniques used and data obtained from work on a variety of aircraft types were reported; microprocessor-based systems were seen as providing the essential technology for major advances in this field. Although the main emphasis was on fatigue loads, the acquisition of design loads data was also discussed, together with the validity of current data bases for loads calculations on high-agility designs representative of the next generation of combat aircraft.

N85-16731# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).
DESIGN FOR TACTICAL AVIONICS MAINTAINABILITY
 Loughton, England Oct. 1984 281 p refs In ENGLISH and FRENCH Conf. held in Brussels, 7-10 May 1984
 (AGARD-CP-361; ISBN-92-835-0366-10) Avail: NTIS HC A13/MF A01

Advanced methods and tools to support design for avionic maintainability and testability are discussed. Both hardware and software design for maintainability issues and approaches are addressed.

01 AERONAUTICS (GENERAL)

N85-16732# Breguet-Aviation, Saint Cloud (France).
OBJECTIVES IN STUDYING THE MAINTAINABILITY OF AIRCRAFT SYSTEMS [OBJECTIFS D'ETUDE DE LA MAINTENABILITE DES SYSTEMES AVIONNES]
M. COURTOIS /n AGARD Design for Tactical Avionics Maintainability 10 p Oct. 1984 refs In FRENCH
Avail: NTIS HC A13/MF A01

Increased use of electronic equipment in combat aircraft results in an increased cost of avionics and of the total purchase price of aircraft. The maintenance of more numerous, more complex, and more costly electronic systems involves maintenance methods which are themselves both numerous and complex. Given the very important acquisition costs of future systems (supplies and replacements will be limited), the maintenance of electronic systems will be an essential function in assuring the maximum operational availability of aircraft. System costs must be reduced to allow for troubleshooting and the verification of aircraft equipment. Different levels of maintenance are analyzed using solutions developed for the Mirage aircraft. Specifications for the maintainability of all equipment, at all levels of maintenance must be established as a function of system architecture and the tests to be conducted. These specifications must be considered from the beginning of prototype equipment study. Transl. by A.R.H.

N85-16734# STTE, Paris (France).
THE EMBEDDED TEST (BIT): IMPACT ON THE TOTAL COST OF POSSESSION [TEST INTEGRE (BIT): IMPACT SUR LE COUT GLOBAL DE POSSESSION]
I. M. KERVELLA /n AGARD Design for Tactical Avionics Maintainability 4 p Oct. 1984 refs In FRENCH
Avail: NTIS HC A13/MF A01

The application of an embedded (built-in) test to digital systems is analyzed. Technical and operational aspects of such tests are discussed and their characteristics as experienced by the French Air Force, are described. The total cost of having built-in tests comprises development, purchase, and operational costs. Results show that the cost of acquiring an embedded test is lightly increased, but is sharply diminished with respect to the cost of acquiring the on-line test formerly used. The cost of using the test should be likewise lower. By taking into consideration the observed operational results, the choice of the embedded test is shown to be satisfactory with respect to service rendered and cost. Transl. by A.R.H.

N85-16735# Aeritalia S.p.A., Torino (Italy).
STUDY AND REALISATION OF A 3RD LEVEL MAINTENANCE CENTER BASED ON ATE SYSTEMS UTILIZATION
F. BOZZOLA /n AGARD Design for Tactical Avionics Maintainability 7 p Oct. 1984
Avail: NTIS HC A13/MF A01

The development of the actual working program for the realisation of a 3rd level maintenance center for the avionics electronics modules of the MRCA Tornado aircraft is discussed. Starting from the initial requirement and from the primary goals of the program, and going through the different study and data collection phases, the adopted general criteria for the definition of the technical characteristics and quantities of the automatic test equipment to be used are described taking into account the testability problems shown by the different electronic boards to be maintained; problems connected with the boards available documentation are also measured. All the problems related to the management, installation, programming, interfacing, expandability and flexibility of the adopted automatic test equipment are discussed. In addition, using the actual maintenance problems faced during the activity development as a starting point, some general maintainability criteria that can be taken into account for similar future programs are outlined. Author

N85-16737# STTE, Paris (France).
ATE USER'S VIEW ON DESIGN FOR MAINTAINABILITY
J. M. G. B. MASCARENHAS /n AGARD Design for Tactical Avionics Maintainability 16 p Oct. 1984 refs
Avail: NTIS HC A13/MF A01

The main features of the Automatic Test Equipment (ATE) that PoAF is using are described. The hardware and software capabilities and limitations are emphasized. Techniques available for test program generation and validation are examined. Views on board design for maintainability (particularly with TE) are presented. B.W.

N85-16739# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (West Germany).
BUILT-IN-TEST FOR FIRST LINE TESTING
W. R. H. BEHM /n AGARD Design for Tactical Avionics Maintainability 7 p Oct. 1984
Avail: NTIS HC A13/MF A01

Built-In-Test requirements were established more than a decade ago to give the maintenance personnel at flight line a help for diagnosis tasks. The prospect of new technology offered automatic, quick, accurate, effective and easy interpretable GO/NOGO information of Line Replaceable Units with built-in self test (BIT) facilities. Typical design goals were: (1) Detection and location of defects down to LRU level with 80% probability and a 90% confidence level at minimum time, and (2) Defective LRUs shall automatically be identified on a Central Maintenance Panel. Whereas the general line of requirements were followed through, some problems occurred, which influenced the final results. These problems are briefly: (1) false alarm probability is higher than was expected; (2) BIT capabilities are less than specified; and (3) BIT is not totally independent of operators interpretation. On the basis of experience gathered during the development of BIT these problems and their reasons were analyzed. B.W.

N85-16740# National Aerospace Lab., Amsterdam (Netherlands).
FUNCTIONAL BUILT-IN-TEST IN A PIPELINED IMAGE PROCESSOR
H. A. VANINGEN SCHENAU, A. PLEIJSIER, and A. MONKEL /n AGARD Design for Tactical Avionics Maintainability 8 p Oct. 1984
Avail: NTIS HC A13/MF A01

A method for built-in-test (BIT) is described which is applied to the test of function modules of a pipeline image processor. The built-in-test is used as a support tool during the early stages of development and for integration and maintenance. The test method takes advantage of the microprocessors used to interface and control the processor modules. Test programs are inserted in the microprocessor software to test the image processor functionally with a similar data and control flow as in real-time operation. The result is a number of test picture which can be interpreted in relation to the programmed functions of the image processing. Use is made of the 2-dimensional image formats to check the performance of the unit at one glance for several functions and parameter values. Author

N85-16743# AEG-Telefunken, Ulm (West Germany).
MAINTAINABILITY: AN ILS EFFORT TO MANIPULATE LCC
M. BOEHM /n AGARD Design for Tactical Avionics Maintainability 15 p Oct. 1984 refs
Avail: NTIS HC A13/MF A01

The concept of maintainability is discussed. The importance of maintainability in controlling the life cycle costs of avionics and radar equipment is evaluated. R.J.F.

N85-16745# LITEF, Freiburg (West Germany).
**DOCUMENTATION AND SEPARATE TEST PROGRAM
 DEVELOPMENT IS MOST IMPORTANT FOR
 TEST/MAINTENANCE**

B. GUSMANN and N. SANDNER /in AGARD Design for Tactical Avionics Maintainability 11 p Oct. 1984 refs

Avail: NTIS HC A13/MF A01

Well defined development phases with standardized documentations supported by computer based tools are important for test and maintenance. Systems for transport aircraft and military applications are discussed. Documentation is stressed throughout the life cycle and the independent testing. B.G.

N85-16752# Naval Electronic Systems Command, Washington, D. C.

A WEAPON SYSTEM DESIGN APPROACH TO DIAGNOSTICS

G. W. NEUMANN (Giordano Associates, Inc., Arlington, Va.) and M. BATTAGLIA /in AGARD Design for Tactical Avionics Maintainability 6 p Oct. 1984 refs

Avail: NTIS HC A13/MF A01

Providing a diagnostics capability for today's weapon systems requires a multifaceted combination of hardware, software, and personnel. The approach to providing this capability is fractionated among a number of different communities (e.g., testing, training, human engineering, publication writers). The result is reflected in the field, where the technician has been furnished a myriad of tools and documentation, which is confusing, complex and often contradictory. The result is lengthy repair times and a waste of manpower and dollars. The basic reason for this diagnostic deficiency is the lack of an integrated design approach to providing this capability and the inability to transition technological advancements to weapon systems acquisitions. Recent Department of Defense and U.S. industry efforts to solve this problem are discussed. R.S.F.

N85-16755# McDonnell Aircraft Co., St. Louis, Mo.
**AVIONICS FAULT TREE ANALYSIS AND ARTIFICIAL
 INTELLIGENCE FOR FUTURE AIRCRAFT MAINTENANCE**

M. E. HARRIS and T. D. SNODGRASS /in AGARD Design for Tactical Avionics Maintainability 12 p Oct. 1984 refs

Avail: NTIS HC A13/MF A01

The avionics fault tree analyzer (AFTA) was developed as an interim support tool for the Navy prior to attainment of total organic support capability, and as an alternate method of support to reduce life cycle/cost for F/A-18 foreign military sales. With the transformation of the AFTA concept from ground support equipment to avionics, a quantitative improvement in life cycle costs will be obtained through the application of artificial intelligence (AI) techniques. The AI is expected to see applications to practical problems in many disciplines; and one of which is the implementation of military fault diagnostic systems. A smart BIT was developed which will reduce false alarms, identify intermittent failures, and improve fault isolation to the lowest possible element by AI technique. Increasing density of computer memory, modularly designed avionic functions and the use of very large scale, and high speed integrated devices will allow future aircraft to fly with the AFTA function. Ramifications such as eliminating the need for intermediate avionic repair facilities, increased aircraft operational readiness, decrease in aircraft recurring costs, and a reduction in spares investment are discussed. The AFTA concept, life cycle cost advantages, and the implementation of artificial intelligence in future avionic designs relative to improved reliability and maintainability are summarized. E.A.K.

N85-16757*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**MISSIONS AND VEHICLE CONCEPTS FOR MODERN,
 PROPELLED, LIGHTER-THAN-AIR VEHICLES**

M. D. ARDEMA Dec. 1984 48 p refs
 (NASA-TM-86672; A-85077; NAS 1.15:86672) Avail: NTIS HC A03/MF A01 CSCL 01B

The results of studies conducted over the last 15 years to assess missions and vehicle concepts for modern, propelled,

lighter-than-air vehicles (airships) were surveyed. Rigid and non-rigid airship concepts are considered. The use of airships for ocean patrol and surveillance is discussed along with vertical heavy lift airships. Military and civilian needs for high altitude platforms are addressed. R.S.F.

N85-16758* National Aeronautics and Space Administration, Washington, D. C.

**AERONAUTICAL ENGINEERING: A CONTINUING
 BIBLIOGRAPHY WITH INDEXES (SUPPLEMENT 182)**

Jan. 1985 140 p

(NASA-SP-7037(182); NAS 1.21:7037(182)) Avail: NTIS HC \$6.00 CSCL 01A

This bibliography lists 475 reports, articles and other documents introduced into the NASA scientific and technical information system in December 1984. Author

N85-16759*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

COMPUTER SIZING OF FIGHTER AIRCRAFT

P. G. COEN and W. E. FOSS, JR. Jan. 1985 22 p Presented at 23rd AIAA Aerospace Sci. Meeting, Reno, Nev., 14-17 Jan. 1985

(NASA-TM-86351; NAS 1.15:86351) Avail: NTIS HC A02/MF A01 CSCL 01B

The computer sizing technique has been applied to a number of military mission profiles. Performance data can be determined for all segments of the selected profile, which typically include takeoff, climb, cruise, loiter, reserve and landing segments. Options are available for detailed calculation of combat performance and energy-maneuverability characteristics. Configuration changes, such as external fuel tank drop and weapon expenditure, can be included in the mission. In the sizing mode, aircraft gross weight, wing loading, and thrust-to-weight ratio are varied automatically to determine which combinations meet the design mission radius. The resulting performance data can be used to create a thumbprint plot. This plot is useful in determining the configuration size that best satisfies the mission and performance requirements. The sizing mode can also be used to perform parametric studies such as sensitivity of gross weight to alternate design conditions. Author

N85-16760# Federal Aviation Administration, Washington, D.C. Office of Management Systems.

**FAA (FEDERAL AVIATION ADMINISTRATION) STATISTICAL
 HANDBOOK OF AVIATION, CALENDAR YEAR 1983 Annual
 Report**

31 Dec. 1984 199 p

(AD-A148171) Avail: NTIS HC A09/MF A01 CSCL 01B

This report presents statistical information pertaining to the Federal Aviation Administration, the National Airspace System, Airports, Airport Activity, U.S. Civil Air Carrier Fleet, U.S. Civil Air Carrier Operating Data, Airmen, General Aviation Aircraft, Aircraft Accidents, Aeronautical Production and Imports/Exports, and a Glossary of the terms used in this publication. Author (GRA)

N85-16761# Logistics Management Inst., Bethesda, Md.

**THE AIR FORCE STOCK FUND AND AIRCRAFT
 AVAILABILITY**

C. H. HANKS Oct. 1984 63 p

(Contract MDA903-81-C-0166)

(AD-A148653; LMI-AF301-4) Avail: NTIS HC A04/MF A01 CSCL 15E

The methods and results of this work represent a first step in quantifying the relation between consumable parts and end-item readiness. This working note addresses the effect on aircraft availability rates if safety levels in the wholesale Air Force stock fund were to change. (Safety levels are the stock levels maintained to cover variations in demand.) The results are that as many as 150 additional aircraft, Air Force-wide, could become unavailable due to parts, if safety levels fell to the extent that wholesale fill rates dropped 5 points, from 85% to 80%. GRA

01 AERONAUTICS (GENERAL)

N85-16762# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

INTERNATIONAL AVIATION (SELECTED ARTICLES)

TONG, W. YE, Z. KEHAN, and Z. ZIQIAN 13 Nov. 1984 32 p Transl. into ENGLISH from Guoji Hang Kong (China), no. 254, Apr. 1984 p 13-19, 46-47

(AD-A148704; FTD-ID(RS)T-0969-84) Avail: NTIS HC A03/MF A01 CSCL 01A

Progress in international aerodynamic research is reported. The development of highly efficient supersonic and highly maneuverable fighter planes is predicted. The structure with forward swept wings has good maneuverability and low transonic drag. Transport aircrafts, V/STOL aircrafts, and fighter aircrafts were tested. Air jet propulsion technology and the development of target tracking display systems are described. E.A.K.

N85-16763# Joint Publications Research Service, Arlington, Va. **USSR REPORT: TRANSPORTATION**

15 Jan. 1985 193 p refs Transl. into ENGLISH from various Russian articles

(JPRS-UTR-85-001) Avail: NTIS HC A09/MF A01

Trends in the design of Soviet aircraft are explored as well as improvements in equipment for agricultural aircraft and in runway surfacing. An automated communication system for Aeroflot and a solution for the braking problems on the IL-76 aircraft are discussed.

N85-16764# Joint Publications Research Service, Arlington, Va. **DIRECTOR ON INSTITUTE'S CIVIL AVIATION PROJECTS**

R. SAKACH *In its* USSR Rept.: Transportation (JPRS-UTR-85-001) p 1-3 15 Jan. 1985 Transl. into ENGLISH from Vozdushnyy Transp. (Moscow), 30 Oct. 1984 p 2

Avail: NTIS HC A09/MF A01

Technologies being developed for the utilization of aircraft in land reclamation and in the use of reclaimed land for agriculture are discussed. The modernization and production of equipment for handling liquid and powered chemicals and biologicals for the An-2 and Ka-26 helicopter; the fitting of aircraft with accessories for cargo drop operations and transporting externally suspended materials; and systems for the aerial observation of crop conditions are needed to increase the nation's food supply. Capabilities of the Tu-134SKh (agricultural) aircraft for the nonphotographic mapping of the Earth's surface are described. A.R.H.

N85-16767# Joint Publications Research Service, Arlington, Va. **INTERNATIONAL PROJECTS, OTHER WORK OF AEROPROYEKT INSTITUTE**

V. BEREZIN *In its* USSR Rept.: Transportation (JPRS-UTR-85-001) p 9-11 15 Jan. 1985 Transl. into ENGLISH from Vozdushnyy Transp. (Moscow), 29 Sep. 1984 p 3

Avail: NTIS HC A09/MF A01

Soviet activities conducted towards implementing an agreement to cooperate in the development of international airports include working with: (1) Cuba to reconstruct the San Jose Marti International Airport; (2) Czechoslovakia to develop a device for evaluating runway surface braking conditions; (3) East Germany on a device for ground servicing of aircraft; (4) Canada on increasing aircraft safety and operational availability, modeling systems for a warning of ice formation, evaluating pavement uniformity, and designing a mobile air terminal; and (5) France on the design of construction methods, equipment, and operational techniques for aircraft. One result of this cooperation is the joint preparation of ICAO recommendations on fuel facility distribution and the development of devices for measuring the runway traction coefficient. A.R.H.

N85-16771# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).

IMPROVEMENT OF AERODYNAMIC PERFORMANCE THROUGH BOUNDARY LAYER CONTROL AND HIGH LIFT SYSTEMS

Loughton (England) Aug. 1984 423 p refs In ENGLISH and FRENCH Conf. held in Brussels, 21-23 May 1984

(AGARD-CP-365; ISBN-92-835-0358-9) Avail: NTIS HC A18/MF A01

Theoretical and experimental developments are reported in the use of both traditional and non-traditional means of boundary layer control for external flow applications such as lift-augmentation, drag reduction and improved effectiveness of controls, and for internal flow applications such as air intakes and exit configurations. Techniques included shaping (geometry) suction and blowing transverse blowing; vortex generators; heating and cooling; and turbulent boundary layer manipulation. Boundary layer control on characteristics of wings and wing-body arrangements that involve flaps, slats and jets (blown flaps), and vortex flaps is covered.

N85-16797# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).

HELICOPTER GUIDANCE AND CONTROL SYSTEMS FOR BATTLEFIELD SUPPORT

Loughton, England Aug. 1984 284 p refs In ENGLISH and FRENCH Conf. held in Monterey, Calif., 8-11 May 1984

(AGARD-CP-359; ISBN-92-835-0365-1) Avail: NTIS HC A13/MF A01

Requirements and operational use of future helicopters; new methods of briefing helicopter crews and tactically setting up the mission systems before and during the flight, flight control, displays, communications, and navigation; sensors and weapon systems integration in overall cockpit design; and simulation and flight research are discussed.

N85-16798# Aerospace Engineering Test Establishment, Cold Lake (Alberta).

OPERATIONAL REQUIREMENTS VERSUS TECHNOLOGICAL CAPABILITIES

S. COYLE *In* AGARD Helicopter Guidance and Control Systems for Battlefield Support 9 p Aug. 1984 refs

Avail: NTIS HC A13/MF A01

The lessons learned in the wartime use of helicopters, and the impact that modern technology can have on what have become common themes are discussed. Lessons learned, the constraints on helicopter operations, and the requirements of the battlefield helicopter are integrated to show where technology would better serve the operators. Performance monitoring, handling qualities and radio communications examples are presented, and a brief outline of how existing technology could be used to update an existing helicopter is made. Author

02

AERODYNAMICS

Includes aerodynamics of bodies, combinations, wings, rotors, and control surfaces; and internal flow in ducts and turbomachinery.

A85-19260#

COMPUTATION OF THREE-DIMENSIONAL FLOWS FOR APPLICATION TO TRANSONIC COMPRESSORS [EXPLOITATION DE CALCULS TRIDIMENSIONNELS DANS LES COMPRESSEURS TRANSSONIQUES]

L. MARRAFFA and A. LE MEUR (ONERA, Chatillon-sous-Bagneux, Hauts-de-Seine, France) ONERA, TP, no. 1984-146, 1984, 14 p. In French.

(ONERA, TP NO. 1984-146)

Features of three-dimensional models for transonic flow through an axial compressor are described. The finite difference code has been implemented in vector form on a computer. An artificial

viscosity is employed to stabilize the calculations and an iterative method is used for a solution after definition of an initial field. Use of a supercomputer has sped the calculations by permitting entry of all grid coordinates and the flow coefficients into the computer memory. The validity of the numerical data is controlled by a governing equation of mass conservation in the flow and using the Euler theorem to detect temperature increases in different regions of the flow. Sample data generated for the pressures on the front and back of a blade oriented downward and the isobaric fields near the top of the channel are provided. It is noted that efforts are needed to structure the calculations so that the volume of data produced can be interpreted in the form of a simple map of the flowfield. M.S.K.

A85-19262#

A SENSOR FOR DETECTION OF UNSTEADY DISTORTION MAXIMA IN AIR INTAKES [DISPOSITIF DE DETECTION DES MAXIMA DE DISTORSION INSTATIONNAIRE DANS LES ENTREES D'AIR]

J. R. BION, B. SELLIER, J. F. OLLIVIER, and M. COMBET (ONERA, Chatillon-sous-Bagneux, Hauts-de-Seine, France) ONERA, TP, no. 1984-148, 1984, 29 p. In French. refs (ONERA, TP NO. 1984-148)

The application of a pitot tube rake for recording unsteady air flow data in ONERA 1/4-scale wind tunnel trials with engine air intake ducts is described. Samples are taken at a 4 kHz rate for valid scaling. The sampling rate has driven the development of a 56 channel PCM system with programmable low pass filters capable of 20 Hz - 5 kHz rates. The PCM system is interfaced with a rapid acquisition system which can sample and filter the data over 64 channels at a peak 20 kHz rate, producing a pressure map every 64 msec. The time constraints for wind tunnel tests have spurred the development of 'gendarmes' to record only the passage of large perturbations. Up to six sensors placed far enough upstream of the rate are interconnected with a minicomputer which is programmed to respond to threshold turbulence levels to initiate and terminate recording of the rake data. The gendarmes are oriented horizontally to forestall production of a wake at the rake probes. M.S.K.

A85-19263#

AERODYNAMIC STUDIES LINKED TO THE DEVELOPMENT OF DEPLOYABLE NOZZLES [ETUDES AERODYNAMIQUES LIEES AU DEVELOPPEMENT DES DIVERGENTS DEPLOYABLES]

A. VENABLES and G. LARUELLE (ONERA, Chatillon-sous-Bagneux, Hauts-de-Seine, France) ONERA, TP, no. 1984-149, 1984, 65 p. In French. refs (ONERA, TP NO. 1984-149)

The results of theoretical and experimental work carried out for 5 yr by ONERA on possible configurations of deployable (some partially retractable) nozzle extensions to enhance upper stage ballistic missile thrust are reported. The discussion is limited to the aerodynamic features of the various designs. Attention is given to the beneficial and detrimental aspects of fluid, annular, panel, mixed, and integrated extensions and a gas-deployable skirt. The deployables were examined for the performances during deployment, which would take place while the engine was already ignited. Their effects on the base drag of the missile stage were found amenable only to experimentation and not numerical modelling. Data from several Mach 5 wind tunnel tests using small rockets are discussed. M.S.K.

A85-19264#

A COMPARISON OF DIFFERENT THREE-DIMENSIONAL SINGULARITY METHODS FOR MODELLING INTERNAL FLOWS [COMPARAISON DE DIFFERENTES METHODES DE SINGULARITES POUR LE CALCUL DES ECOULEMENTS INTERNES EN TRIDIMENSIONNEL]

C. KIRRMANN (ONERA, Chatillon-sous-Bagneux, Hauts-de-Seine, France) ONERA, TP, no. 1984-150, 1984, 36 p. In French. refs

(ONERA, TP NO. 1984-150)

The capabilities of two singularity methods for modelling the interaction between an engine nacelle and a wing are compared. The classic method features Neumann constraints on the concealed surfaces of the panel sources. The lifting bodies are expressed as a skeleton of doublets with intensities fixed by an arbitrary distribution law and a Kutta-Joukowski condition. The second method supposes interior Dirichlet conditions and exterior Neumann limits with hidden closed surfaces of mixed doublet-source panels. The classic method is found to be sensitive to the grid density and the law of internal doublets selected. The Dirichlet scheme, however, is less grid-sensitive, allows regularization for the interior flow, and reduces parietal leakage. Several features of the REHBACH program, which incorporates the Dirichlet model, are discussed. M.S.K.

A85-19401#

AN IMPROVED VERSION OF THE LTRAN2 FOR HIGH FREQUENCY DOMAIN

J. NAKAMICHI (National Aerospace Laboratory, Chofu, Tokyo, Japan) Japan Society for Aeronautical and Space Sciences, Transactions (ISSN 0549-3811), vol. 27, Nov. 1984, p. 121-133. refs

In the present study, the NASA Ames code, LTRAN2 is improved in order that it may be employed to predict unsteady aerodynamic loads on an airfoil oscillating even in high frequency. The modified version presented here is based upon a two-dimensional full transonic small perturbation equation. The main modifications are obtained by adding appropriate higher order terms with respect to time, to the governing equation and to the boundary conditions. These modifications are carried out without any decrease in the accuracy of the solutions and without loss of the conservation property of the scheme. An alternating-direction-implicit finite difference algorithm is presented for the improvements. The results obtained demonstrate both the theoretical and practical feasibility of the present version for predicting the unsteady transonic aerodynamic loads on the two-dimensional airfoils in motions of high frequency, up to the reduced frequency, $k = 0.8$. Author

A85-19404#

COMPARATIVE STUDY OF VARIOUS QUADRATURES FOR SUBSONIC LIFTING SURFACE CHORDWISE INTEGRALS

S. ANDO (Nagoya University, Nagoya, Japan), D.-H. LEE (Ulsan Institute of Technology, Ulsan, Republic of Korea; Nagoya University, Nagoya, Japan), and K. ASAMI (Kawasaki Heavy Industries, Ltd., Gifu, Japan) Japan Society for Aeronautical and Space Sciences, Transactions (ISSN 0549-3811), vol. 27, Nov. 1984, p. 155-168. refs

Chordwise quadrature methods employed in numerical computations of unsteady subsonic lifting-surface problems are compared analytically by applying them to integrals containing kernel functions, one with a Cauchy-type singularity and one with a logarithmic singularity. The results are presented in graphs and tables and discussed. Although no single method satisfies all of the ideal requirements (wide applicability, rapid computation, and automatic achievement of a prescribed degree of accuracy), the method of Alway (1960) or a combination of Gaussian quadrature and the adaptive Newton-Cotes method of Ninomiya (1980) for different domains of the parameter Y are found to give the best results for the Cauchy-singularity case. A new method developed in an appendix to the present paper is shown to provide the best accuracy for the logarithmic-singularity integral. T.K.

A85-19405#

AN ANALYSIS OF THE FLOW PAST AN S-SHAPED ROTOR BY DISCRETE VORTEX MODEL

E. HATAYAMA, H. NAKATANI, and Y. MIYAI (Osaka Prefecture University, Sakai, Japan) Japan Society for Aeronautical and Space Sciences, Transactions (ISSN 0549-3811), vol. 27, Nov. 1984, p. 169-183. refs

A discrete vortex model has been applied to various separated flow problems, but its application to rotating body problems has been limited to simple cases. In this study, the discrete vortex model together with the conformal mapping method has been applied to analyze the flow around a rotating S-shaped aerofoil having a comparatively complicated mapping function, as the first step to know the flow past the rotor of a windmill with a vertical axis. Numerical calculations are performed for three different types of S-shaped rotor at two tip speed ratios, then the vortex pattern, unsteady moment and forces are obtained. From the calculations, it has been found that the vortex pattern is remarkably influenced by the rotor shape, and that the variations of the moment and forces with the rotating angle show different tendencies with respect to the tip speed ratio. Author

A85-19406#

APPLICATION OF LASER INTERFEROMETRY TO DENSITY MEASUREMENTS IN FREE JETS

H. KOBAYASHI, T. NAKAGAWA, and M. NISHIDA (Kyoto University, Kyoto, Japan) Japan Society for Aeronautical and Space Sciences, Transactions (ISSN 0549-3811), vol. 27, Nov. 1984, p. 184-192. refs

Laser interferometry using Wollaston prisms has been applied to density measurements in freely expanding flows issuing from a sonic orifice. The radially resolved densities have been determined by means of the Abel inversion under the assumption of an axisymmetric flow. Thus determined densities have been compared with those predicted using the formula for a Mach number in the free jet proposed by Ashkenas and Sherman (1966). The comparison shows a fairly good agreement between the experimental and predicted results in the region surrounded by the barrel shock and Mach disk, except for the flow field near the orifice. Author

A85-19439#

THEORETICAL STUDY ON SUPERSONIC JET PLUMES

L. C. CHIEN, T. C. WANG, J. C. LIANG, and F. L. CHEN (Academia Sinica, Institute of Physics, Taipei, Republic of China) Chinese Society of Mechanical Engineers, Journal, vol. 4, Oct. 1983, p. 1-18. refs

The supersonic jet of rocket exhaust plumes under various altitudes are investigated by two numerical techniques. Method of characteristics, which the computational procedures are set up similar to the formation process of actual flow, was first employed to solve the plumes of two standard nozzles under various exhaust and ambient conditions. The results are compared with the existing solutions nicely. For an objectly comparison, the Lagrangian finite difference method which operates in the natural coordinates system was devoted to calculate the same jet plumes. It is found that the results obtained by different numerical techniques are in good agreement. Furthermore, the results are also found that they agree with physical phenomena as well. Author

A85-19451*# Bolt, Beranek, and Newman, Inc., Cambridge, Mass.

AN EXPERIMENTAL INVESTIGATION OF BLADE-VORTEX INTERACTION AT NORMAL INCIDENCE

A. R. AHMADI (Bolt Beranek and Newman, Inc., Cambridge, MA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 17 p. refs (Contract NAS2-11313) (AIAA PAPER 85-0003)

An experimental investigation has been conducted for the blade-vortex interaction (BVI) of a rotor at normal incidence, where the vortex is generally parallel to the rotor axis. Tip Mach number, radial BVI station, and free stream velocity were varied during

measurements of fluctuating blade pressures, far field sound pressure levels and directivity, incident vortex velocity field, and blade-vortex interaction angles. The experimental setup is representative of the chopping of helicopter main rotor tip vortices by the tail rotor. This interaction is found to generate impulsive noise which radiates primarily ahead of the blade. O.C.

A85-19452#

INTERACTION OF A TURBULENT VORTEX WITH A LIFTING SURFACE

D. J. LEE and L. ROBERTS (Stanford University, Stanford, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 11 p. refs (AIAA PAPER 85-0004)

The impulsive noise due to blade-vortex-interaction is analyzed in the time domain for the extreme case when the blade cuts through the center of the vortex core with the assumptions of no distortion of the vortex path or of the vortex core. An analytical turbulent vortex core model, described in terms of the tip aerodynamic parameters, is used and its effects on the unsteady loading and maximum acoustic pressure during the interaction are determined. Author

A85-19454#

NUMERICAL SOLUTIONS OF VISCOUS TRANSONIC FLOW IN TURBOMACHINERY CASCADES

V. IYER and E. VON LAVANTE (Texas A&M University, College Station, TX) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 9 p. refs (AIAA PAPER 85-0007)

The present work is on the numerical solution of the Navier-Stokes equations for transonic flow in compressor cascades and other internal geometries. Two basic algorithms, the bidiagonal implicit algorithm and the approximate factorization implicit algorithm, are considered along with their modified versions. The results are compared to one another and also to inviscid results obtained by other investigators. Author

A85-19455#

AN EXPERIMENTAL INVESTIGATION OF STATOR/ROTOR INTERACTION INFLUENCE ON MULTISTAGE COMPRESSOR ROTOR FLOW

D. L. TWEEDT, T. H. OKIISHI (Iowa State University of Science and Technology, Ames, IA), and M. D. HATHAWAY (U.S. Army, Research and Technology Laboratories, Cleveland, OH) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 9 p. refs (Contract F49620-83-K-0023) (AIAA PAPER 85-0009)

Time-averaged total-head measurements and warm air tracking observations for the second-stage rotor of a low-speed, two-stage, axial-flow compressor are presented and discussed. Some unusual aspects of the detailed distribution of total head in the rotor exit flow are explained in terms of first-stage stator/second-stage rotor viscous interaction. Author

A85-19460#

EULER SOLUTION OF AXISYMMETRIC FLOWS ABOUT BODIES OF REVOLUTION USING A MULTIGRID METHOD

C. J. WOAN (Rockwell International Corp., North American Aircraft Operations Div., Los Angeles, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 11 p. Research supported by the Rockwell International Independent Research and Development Program. refs (AIAA PAPER 85-0017)

Jameson's airfoil Euler code FLO52MG, based on a new class of multistage time stepping schemes in conjunction with enthalpy damping, variable local time step, implicit residual averaging, and multigrid technique to produce a rapid convergence to steady-state, is modified for calculating axisymmetric flows about bodies of revolution. Comparisons of results for a sphere and three AGARD

experimental-data-base configurations with exact solutions and test data show very good agreement. Gridding effect on numerical convergence is discussed. The usual airfoil-type mesh with grid points being clustered near the leading-edge often resulted in solution divergence although residuals may initially be reduced to within engineer tolerance. Extension of the modified program to inlet flows is straightforward. Author

A85-19461#
AERODYNAMICS OF AN AIRFOIL IN GROUND EFFECT WITH A JET ISSUING FROM ITS UNDERSURFACE

R. K. AGARWAL and J. E. DEESE (McDonnell Douglas Research Laboratories, St. Louis, MO) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 9 p. refs
 (AIAA PAPER 85-0019)

Potential flow models employing the jet-flap theory are inadequate for simulating the flowfield around an airfoil in ground effect with a jet issuing from its undersurface. Euler equations serve as a better physical model because they do not require the assumption of an infinite open wake behind the jet with pressure equal to the free-stream pressure. Euler equations can also capture the vortex formation behind the jet and most of the airfoil/jet/ground-plane interaction, except the effect of entrainment. In this paper, airfoil/jet/ground-interaction flowfields are calculated by solving Euler equations on body-conforming curvilinear grids. Author

A85-19469#
CURRENT STATUS OF NUMERICAL SOLUTIONS OF THE NAVIER-STOKES EQUATIONS

R. W. MACCORMACK (Washington, University, Seattle, WA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 14 p. refs
 (Contract AF-AFOSR-83-0057)
 (AIAA PAPER 85-0032)

Past and present limitations to the numerical solution of the compressible Navier-Stokes equations are examined. New procedures to accelerate convergence, including line Gauss-Seidel and Newton iteration, are described and tested. The calculation of viscous flow solutions at high Reynolds numbers in less than twenty time step iterations is demonstrated. Author

A85-19470*# Bari Univ. (Italy).
AN INCREMENTAL BLOCK-LINE-GAUSS-SEIDEL METHOD FOR THE NAVIER-STOKES EQUATIONS

M. NAPOLITANO (Bari, Università, Bari, Italy) and R. W. WALTERS (NASA, Langley Research Center, Hampton, VA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 10 p. Research supported by the Ministero della Pubblica Istruzione. refs
 (Contract N00014-82-K-0184)
 (AIAA PAPER 85-0033)

A block-line-Gauss-Seidel (LGS) method is developed for solving the incompressible and compressible Navier-Stokes equations in two dimensions. The method requires only one block-tridiagonal solution process per iteration and is consequently faster per step than the linearized block-ADI methods. Results are presented for both incompressible and compressible separated flows: in all cases the proposed block-LGS method is more efficient than the block-ADI methods. Furthermore, for high Reynolds number weakly separated incompressible flow in a channel, which proved to be an impossible task for a block-ADI method, solutions have been obtained very efficiently by the new scheme. Author

A85-19472*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

A MULTISTAGE TIME-STEPPING SCHEME FOR THE NAVIER-STOKES EQUATIONS

R. C. SWANSON (NASA, Langley Research Center, Theoretical Aerodynamics Branch, Hampton, VA) and E. TURKEL (Tel Aviv University, Tel Aviv, Israel) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 15 p. refs
 (Contract NAS1-17070)
 (AIAA PAPER 85-0035)

A class of explicit multistage time-stepping schemes is used to construct an algorithm for solving the compressible Navier-Stokes equations. Flexibility in treating arbitrary geometries is obtained with a finite-volume formulation. Numerical efficiency is achieved by employing techniques for accelerating convergence to steady state. Computer processing is enhanced through vectorization of the algorithm. The scheme is evaluated by solving laminar and turbulent flows over a flat plate and an NACA 0012 airfoil. Numerical results are compared with theoretical solutions or other numerical solutions and/or experimental data. Author

A85-19473#
CALCULATION OF COMPRESSIBLE POTENTIAL FLOW ABOUT MULTIELEMENT AIRFOILS USING A FINITE FIELD-PANEL APPROACH

N. D. HALSEY (Douglas Aircraft Co., Long Beach, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 9 p. refs
 (Contract NSF MEA-80-18565)
 (AIAA PAPER 85-0038)

A method for calculating the subsonic, compressible potential flow over general two-dimensional multielement airfoils has been developed. Such a method is needed for high-lift flows, even those with very low freestream Mach numbers, because local velocities become very large near the airfoil leading edges. The method uses the source field-panel approach which, at least for subcritical flows, may have significant computational advantages over the more common finite-difference approach. Unlike previous field-panel methods, this method employs efficient conformal mapping and fast Fourier transform algorithms in both the grid-generation and flow-solver parts of the calculations. Method development and results are described for two-element airfoil cases, while the broad features of the extension to cases with three or more airfoil elements are briefly outlined. Author

A85-19474#
AN EXPERIMENTAL INVESTIGATION OF AN AIRFOIL UNDERGOING LARGE AMPLITUDE PITCHING MOTIONS

J. M. WALKER, H. E. HELIN (USAF, Frank J. Seiler Research Laboratory, Colorado Springs, CO), and J. H. STRICKLAND (USAF, Frank J. Seiler Research Laboratory, Colorado Springs, CO; Texas Tech University, Lubbock, TX) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 7 p. refs
 (Contract F49620-82-C-0035)
 (AIAA PAPER 85-0039)

Flow-visualization and near-surface hot-wire experiments were performed in the USAF Academy Aeronautics Laboratory 2 x 3-ft subsonic wind tunnel on an airfoil undergoing large-amplitude pitching motions. The experiments were conducted using a 6-in. NACA 0015 airfoil at an airfoil Reynolds number of 45,000 by pitching from 0 to 60 deg at various constant angular-pitch rates. The two cases presented represent two different nondimensional pitching rates, $\alpha(+)$, equal to the ratio of the product of the pitch rate, and the chord to the freestream velocity. Data for the two cases where values of $\alpha(+)$ were equal to 0.2 and 0.6 show the dramatic effect of pitch rate on flow structure. Large-scale vortical structures are seen in both cases but appear in different form at higher angles of attack for the larger $\alpha(+)$ value. These structures are very energetic, producing reverse flow velocities near the airfoil surface of 1-2.5 times the freestream velocity. Author

A85-19475*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

TURBULENCE FLOW AROUND A WING-FUSELAGE TYPE JUNCTURE

L. R. KUBENDRAN (NASA, Langley Research Center, Hampton, VA), H. M. MCMAHON, and J. E. HUBBARTT (Georgia Institute of Technology, Atlanta, GA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 10 p. refs

(Contract NAG1-40)

(AIAA PAPER 85-0040)

The flow over a 58-mm-thick uniform-thickness winglike body having a 1.5:1 elliptical leading edge and joined to a large flat plate (representing an aircraft fuselage) is characterized experimentally at freestream velocity 15 m/s, corresponding to Reynolds number 940,000/m, using hot-wire anemometry. The results are presented graphically, and it is found that the horseshoe vortex formed by the separation of the fuselage boundary layer ahead of the wing leading edge is effective in transporting turbulence and modifying the mean-flow characteristics and the turbulent-stress distribution. It is suggested that the slenderness ratio of the leading edge is the dominant factor affecting the strength and location of the vortex.

T.K.

A85-19476#

THREE-DIMENSIONAL EFFECTS ON A PITCHING LIFTING SURFACE

M. GAD-EL-HAK (Flow Research Co., Kent, WA) and C.-M. HO (Southern California, University, Los Angeles, CA; Flow Research Co., Kent, WA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 13 p. refs

(Contract F49620-82-C-0020)

(AIAA PAPER 85-0041)

The low Reynolds number, time-dependent flow around two generic classes of wings is studied in a water towing tank. Delta and swept (including zero sweep) wings were sting-mounted to a four-bar mechanism which generated a large amplitude, harmonic pitching motion around the 1/4-chord location, at a reduced frequency that varied in the range of 0.2 to 3. Fluorescent dye-layers were placed in the weakly-stratified water channel prior to towing the wing. The horizontal dye sheets were excited using a vertical sheet of laser light. The dye marked the flow in the separation region around the wing, the wake region, and the potential flow away from the lifting surface. The complex, time-dependent flow field around the different wings can be mostly explained from the mutual induction between the leading edge separation vortex and the trailing edge shedding vortex. The reduced frequency, the shape of the leading edge, and the wing's planform play important roles in determining the flow patterns.

Author

A85-19477#

COMPUTATIONAL STUDY OF CIRCULATION CONTROL WITH SUCTION

R. HIMENO, K. KUWAHARA, and T. KAWAMURA (Tokyo, University, Tokyo, Japan) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 9 p. refs

(AIAA PAPER 85-0042)

The effects of circulation control by means of suction are studied computationally via a higher-order upwind scheme. Elliptic and oval airfoils with various thickness ratio are treated. Dependence on the various parameters is investigated. Because the suction position has a very important effect on lift/drag, special effort has been made to check its position. Also, dependence on the thickness ratio of the airfoil is shown.

Author

A85-19478#

TURBULENCE STRUCTURE OF A THREE DIMENSIONAL IMPINGING JET IN A CROSS STREAM

M. V. SHAYESTEH, P. BRADSHAW (Imperial College of Science and Technology, London, England), and I. M. M. A. SHABAKA (Cairo University, Cairo, Egypt; Imperial College of Science and Technology, London, England) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 12 p. USAF-supported research. refs

(AIAA PAPER 85-0044)

Extensive measurements have been made in turbulent jets which emerge from circular nozzles into a cross-stream, and then impinge on a flat surface perpendicular to the nozzle axis. Such flows are found in impingement-cooling applications and below a VTOL aircraft hovering in a headwind. Data were obtained with conventional hot-wire anemometers and, in regions of high turbulence intensity or reversed flow, with a pulsed-wire anemometer. Data include all components of mean velocity, and all Reynolds stresses and triple products of velocity fluctuations. The results show the presence of a pronounced trailing vortex system, and also the large effects of flow distortion on the turbulence structure parameters that determine the empirical constants in engineering models of turbulence.

Author

A85-19479#

THE EFFECT OF PHASE-DIFFERENCE ON THE SPREADING RATE OF A LAMINAR CIRCULAR JET UNDER BI-MODAL EXCITATION

R. R. MANKBADI (Rutgers University, New Brunswick, NJ) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 9 p. refs

(AIAA PAPER 85-0045)

The role of initial phase difference between fundamental and subharmonic instability waves on the spreading rate of a circular jet under bi-modal excitation is investigated theoretically. For all Strouhal numbers considered, the initial growth rate of the subharmonic was found to be a maximum when the two waves are initially in-phase. The effect of the phase-difference on the subharmonic's peak is dependent on Strouhal number. The development of the momentum thickness along the jet is characterized by regions of step-wise growth. The momentum thickness first increases as the fundamental amplifies. This growth region is followed by a region where the decay of the fundamental and the growth of the subharmonic result in a constant momentum thickness. Once the fundamental has fully decayed, the momentum thickness grows again as a result of the subharmonic's amplification. The growth rate is dependent on the initial phase difference and is maximum when the subharmonic suffers maximum amplification.

Author

A85-19480#

THE INTERACTION AND MERGING OF TWO TURBULENCE LINE VORTICES

A. J. SMITS (Princeton University, Princeton, NJ) and R. P. KUMMER American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 12 p. refs

(AIAA PAPER 85-0046)

An experimental investigation of the interaction and merging of two turbulent line vortices is described. The vortices were generated by two airfoils set at opposite angles of attack, and they were of opposite sign and equal strength. As the vortices proceed downstream they rotate around each other, and eventually they merge to produce a dominant, central vortex, with vestigial traces of the original vortices. Mean flow and turbulence measurements were made throughout the merging zone. The circulation profiles varied logarithmically with radius, for a considerable radial extent, at all stations. The turbulent shear stresses appeared to be simply related to the mean velocity gradients, and it seems that first-order turbulence models may be adequate to describe the merging process.

Author

A85-19482*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

VORTEX RESEARCH FACILITY IMPROVEMENTS AND PRELIMINARY DENSITY STRATIFICATION EFFECTS ON VORTEX WAKES

D. R. SATRAN, G. T. HOLBROOK, G. C. GREENE (NASA, Langley Research Center, Hampton, VA), and D. NEUHART (NASA, Langley Research Center; Kentron International, Inc., Hampton, VA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 14 p. refs (AIAA PAPER 85-0050)

Recent modernization of NASA's Vortex Research Facility is described. The facility has a 300-ft test section, scheduled for a 300-ft extension, with constant test speeds of the model up to 100 ft/sec. The data acquisition hardware and software improvements included the installation of a 24-channel PCM system onboard the research vehicle, and a large dedicated 16-bit minicomputer. Flow visualization of the vortex wake in the test section is by particle seeding, and a thin sheet of argon laser light perpendicular to the line of flight; detailed flow field measurements are made with a laser velocimeter optics system. The improved experimental capabilities of the facility were used in a study of atmospheric stratification effects on wake vortex decay, showing that the effects of temperature gradient must be taken into account to avoid misleading conclusions in wake vortex research. L.T.

A85-19484#

A NOVEL EXPERIMENTAL FACILITY FOR CONDUCTING JET IMPINGEMENT STUDIES RELATED TO VTOL AIRCRAFT

K. R. SARIPALLI and J. C. KROUTIL (McDonnell Douglas Research Laboratories, St. Louis, MO) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 9 p. refs (AIAA PAPER 85-0052)

A novel experimental facility using water as the working medium has been designed and built to study multiple jet impingement flowfields, with specific application to vertical-take-off-and-landing (VTOL) aircraft. The components of this facility and the associated equipment are described in detail. An account is given of performance tests conducted on the facility which included diagnostic flow visualization and measurements. Flow-visualization studies conducted on a model VTOL aircraft to study the near-field exhaust flow patterns in ground effect are described. Author

A85-19487#

EXAMINING THE VALIDITY OF A COMBUSTOR FLOW MODEL WITH LDV

G. O. KRAEMER (Avco Corp., Lycoming Div., Stratford, CT) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 7 p. refs (AIAA PAPER 85-0055)

Laser Doppler velocimetry was used to map the flow field within a PLT-34 annular combustor liner at ambient conditions. This combustor design produces a primary zone flow field resembling a horseshoe shaped mean circulation path centered about the fuel injector. This combustor design was chosen because of the three-dimensionality of the flow field and its use in AVCO-Lycoming engines. Overall the combustor flow model, INTERN, was found to provide good qualitative and reasonable quantitative description of this complex flow field. However, the model underpredicts the fine detail of the high velocity jets and the rms velocity. In consideration of the coarseness of the grid used and approximate modeling of the combustor geometry, the overall agreement is considered good. Author

A85-19489*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

ACCELERATED CONVERGENCE FOR INCOMPRESSIBLE FLOW CALCULATIONS

G. M. NEELY and R. W. CLAUS (NASA, Lewis Research Center, Cleveland, OH) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 8 p. Previously announced in STAR as N85-10949. refs (AIAA PAPER 85-0058)

Two improved algorithms which solve the steady-state Navier-Stokes equations, PISO and SIMPLER, are studied. Computations were carried out on progressively finer grids for the driven cavity and flow over a backward-facing step. The effects of relaxation factor, number of grid nodes and number of sweeps through the pressure equations are studied to evaluate the performance of the PISO and SIMPLER schemes. Results show that these improved schemes accelerate the convergence rate of the solution generally by a factor of two as compared to the SIMPLE method. Author

A85-19490*# Texas Technological Univ., Lubbock.

FLOW VISUALIZATION OF LATERAL JET INJECTION INTO SWIRLING CROSSFLOW

G. B. FERRELL (Texas Tech University, Lubbock, TX; Oklahoma State University, Stillwater, OK), K. AOKI (Oklahoma State University, Stillwater, OK; Tokai University, Hiratsuka, Japan), and D. G. LILLEY (Oklahoma State University, Stillwater, OK) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 12 p. refs (Contract NAG3-159) (AIAA PAPER 85-0059)

Flow visualization experiments have been conducted to characterize the time-mean flowfield of a deflected turbulent jet in a confining cylindrical crossflow. Jet-to-crossflow velocity ratios of 2, 4, and 6 were investigated, under crossflow inlet swirler vane angles of 0 (swirler removed), 45 and 70 degrees. Smoke, neutrally-buoyant helium-filled soap bubbles, and multi-spark flow visualization were employed to highlight interesting features of the deflected jet, as well as the trajectory and spread pattern of the jet. Gross flowfield characterization was obtained for a range of lateral jet-to-crossflow velocity ratios and a range of inlet swirl strengths in the main flow. The flow visualization results agree well with the measurements obtained elsewhere with the six-orientation single hot-wire method. Author

A85-19500#

THE DESIGN OF AIRFOILS AT LOW REYNOLDS NUMBERS

M. S. SELIG (Illinois, University, Urbana, IL) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 11 p. refs (AIAA PAPER 85-0074)

This paper focuses on the design of airfoils at low Reynolds numbers (100,000-500,000), specifically those applicable to radio-controlled model sailplanes. Two common types of airfoil lift and drag hysteresis are illustrated and explained in terms of the behavior of the upper-surface transitional separation bubble which is commonly present at these low Reynolds numbers. The theoretical section characteristics of several airfoils predicted by the Eppler (1980) computer program for the design and analysis of low-speed airfoils were compared with the recent experimental data of Althaus (1980). Good correlation was found between the type of hysteresis and the general character of the pressure distribution. Also, the validity of the predicted section characteristics is discussed for this low Reynolds number regime. From the comparisons the desirable qualities of a low Reynolds number airfoil were determined. Based on this several airfoils for radio-controlled model sailplanes were subsequently designed and analyzed using the Eppler computer program. Author

A85-19501#

A COMPARISON OF FLIGHT TEST AND ANALYTICAL TECHNIQUES FOR BOUNDARY LAYER TRANSITION ON A SAILPLANE

K. MILLER (USAF, Edwards AFB, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 10 p. refs (AIAA PAPER 85-0075)

Practical techniques for using pigmented oil and sublimating chemicals to reveal inflight boundary layer transition were developed and compared. Pigmented oil was found relatively simple to use and produced photographs with transition clearly defined at all but high angles of attack. Low temperatures increased the viscosity of the oil to the point that temperatures slightly below standard day resulted in no indication of transition. Temperature variations were a factor with the sublimation technique also. In general, the flight test results compared favorably with data from the Eppler-Somers airfoil analysis code. At angles of attack below eight degrees, the transition locations indicated by the pigmented oil are within 5 percent chord of the predicted locations. Practical procedures are recommended. Author

A85-19508*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

ON BOUNDARY LAYER TRANSITION IN HIGH-SUBSONIC AND TRANSONIC FLOW UNDER THE INFLUENCE OF ACOUSTIC DISTURBANCES AND FREE-STREAM TURBULENCE

S. V. MURTHY and F. W. STEINLE (NASA, Ames Research Center, Moffett Field, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 12 p. refs (AIAA PAPER 85-0082)

The existing data base which quantifies the roles played by the Mach number, turbulence level, and acoustic noise in the flow quality of wind tunnels is reviewed. Attention is given to the effects on end (ET) and beginning (BT) transitions in flows over a 10 deg cone in transonic channels. The Re of both ET and BT flows were significantly affected by the Mach number, acoustic noise level and the noise frequency content. A unit increment in the Mach number increased the Re beyond 3,000,000, while noise below the 1 percent level in the rms pressure coefficient did not alter the transition phenomenon. More data are required on the effects of turbulence, which was a significant factor, and in the settling chamber, test section, plenum and diffuser to trace the locations and magnitudes of the acoustic sources. M.S.K.

A85-19510*# United Technologies Research Center, East Hartford, Conn.

THREE-DIMENSIONAL INVISCID FLOW ANALYSIS OF TURBOFAN FORCED MIXERS

T. J. BARBER, G. L. MULLER, S. M. RAMSAY (United Technologies Research Center, East Hartford, CT), and E. M. MURMAN (MIT, Cambridge, MA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 14 p. refs (Contract NAS3-23039) (AIAA PAPER 85-0086)

A three-dimensional potential analysis has been formulated and applied to the inviscid flow over a turbofan forced mixer. The method uses a unique small disturbance formulation to analytically uncouple the circumferential flow from the radial and axial flow problem, thereby reducing the analysis to the solution of a series of axisymmetric problems. These equations are discretized using a flux volume formulation along a Cartesian grid. The method extends earlier applications of the Cartesian method to complex cambered geometries. The effects of power addition are also included within the potential formulation. Good agreement is obtained with an alternate small disturbance analysis for a symmetric mixer in a planar duct. In addition calculations showing pressure distributions and induced secondary vorticity fields are presented for practical turbofan mixer configurations, and where possible, comparison has been made with available experimental data. Author

A85-19511#

A QUASI-CONSERVATIVE LAMBDA FORMULATION

A. DADONE and V. MAGI (Bari, Università, Bari, Italy) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 11 p. Research supported by the Ministero della Pubblica Istruzione and Consiglio Nazionale delle Ricerche. refs (AIAA PAPER 85-0088)

A modified lambda formulation is demonstrated to be capable of simulating transonic inviscid flows. A technique for coupling the supersonic region with the subsonic region by means of a shock is defined. The method's ability to depict a shock is illustrated in terms of a simplified one-dimensional flow applied to three transonic nozzle flows. The technique is extended to nonisentropic one- and two-dimensional flows of a gas with a ratio of specific heats not equal to one. Solutions are obtained that are commensurate with solutions derived by exact methods, showing that the modified lambda method can model the forward movement of the shock. M.S.K.

A85-19523#

FLOWS OVER LOW REYNOLDS NUMBER AIRFOILS - COMPRESSIBLE NAVIER-STOKES NUMERICAL SOLUTIONS

A. P. KOTHARI and J. D. ANDERSON, JR. (Maryland, University, College Park, MD) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 15 p. refs (Contract N00014-81-K-2037; N00014-84-K-0181) (AIAA PAPER 85-0107)

Laminar and transitional turbulent compressible two-dimensional viscous flows over Miley and Wortmann airfoils at Reynolds numbers 500-300,000 are investigated analytically. A finite-difference implicit procedure is applied to solve the Navier-Stokes equations, and the results are compared presented graphically and compared with experimental data (Mueller, 1984): good agreement is obtained. Both laminar and turbulent flows with large separation are found to be unsteady, while the nonseparated flows are steady. T.K.

A85-19524*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

A THEORY FOR THE CORE OF A THREE-DIMENSIONAL LEADING-EDGE VORTEX

J. M. LUCKRING (NASA, Langley Research Center, Transonic Aerodynamics Div., Hampton, VA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 15 p. refs (AIAA PAPER 85-0108)

A theory is presented for the flow in the core of a separation-induced leading-edge vortex. The theory is based on matching inner and outer representations of the vortex. The inner representation models continuously distributed vorticity and includes an asymptotic viscous subcore. The outer representation models concentrated spiral sheets of vorticity and is fully three dimensional. A parameter is identified which closely tracks the vortex breakdown stability boundary for delta, arrow, and diamond wings. Author

A85-19526*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

A COMPARISON OF EULER AND NAVIER-STOKES SOLUTIONS FOR SUPERSONIC FLOW OVER A CONICAL DELTA WING

R. W. NEWSOME (NASA, Langley Research Center; USAF, Wright Aeronautical Laboratories, Hampton, VA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 12 p. refs (AIAA PAPER 85-0111)

The flow around a thin elliptic cone at Mach number 2 and angle of attack 10 deg is simulated numerically, comparing the results obtained using a fine grid and the Navier-Stokes (NS) equations with those obtained using both coarse and fine grids and the Euler (E) equations. On the coarse grid, the E results are found to reproduce roughly the NS predictions of leading-edge

separation and primary and secondary vortices on the leeward surface, but the E solution on the fine NS grid (showing no separation and a crossflow-shock-induced vorticity) reveals this agreement to be spurious. The fine-grid E prediction is shown to be a valid solution of the E equations, indicating their unsuitability as approximators of viscous flow. The imposition of a Kutta condition on the E computation is found to be ineffective in correcting this discrepancy. T.K.

A85-19531#

SOLUTION OF THE UNSTEADY EULER EQUATIONS FOR FIXED AND ROTOR WING CONFIGURATIONS

N. L. SANKAR, B. E. WAKE, and S. G. LEKOUKIS (Georgia Institute of Technology, Atlanta, GA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 11 p. Army-supported research. refs (AIAA PAPER 85-0120)

A solution procedure is described for the numerical solution of inviscid rotational flow past fixed and rotor wing configurations. This procedure solves the three-dimensional Euler equations in a body-fitted coordinate system and in strong conservation form. The derivatives along the spanwise direction are lagged by one time step, while all the other terms are treated in a fully implicit manner. This leads to a semi-implicit scheme that requires two block tridiagonal matrix inversions and one residual evaluation per point at every time step. This procedure also requires the flow variables to be stored at only one time level. A number of fixed wing and rotor wing calculations are presented to demonstrate the efficiency and accuracy of this procedure. Author

A85-19532#

THREE-DIMENSIONAL EULER SOLUTIONS WITH GRID EMBEDDING

T. J. BAKER, A. JAMESON (Princeton University, Princeton, NJ), and R. E. VERMELAND (McDonnell Aircraft Co., St. Louis, MO; Princeton University, Princeton, NJ) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 11 p. refs (AIAA PAPER 85-0121)

An embedded mesh has been introduced into the three-dimensional Euler method for calculating flows over wing/body/tail combinations. The enriched mesh surrounds the tail and provides a reasonable resolution of the flow field there. Comparisons between theory and experiment are presented for the pressure distribution over the tail of the Boeing 747-200. Author

A85-19533*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

A COMPARISON OF FINITE VOLUME FLUX VECTOR SPLITTINGS FOR THE EULER EQUATIONS

W. K. ANDERSON, J. L. THOMAS (NASA, Langley Research Center, Hampton, VA), and B. VAN LEER (Delft, Technische Hogeschool, Delft, Netherlands) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 16 p. refs (AIAA PAPER 85-0122)

A comparison is made between the computational results of the Steger-Warming (1981) and van Leer (1982) flux splitting methods, which have been applied in generalized coordinates to quasi-one-dimensional transonic flow in a nozzle and two-dimensional subsonic, transonic, and supersonic flow over airfoils. The latter splitting method leads to higher convergence rates and a sharper representation of shocks in the transition region. The second-order accurate, one-sided-difference model is extended to a third-order, upwind-biased model with only small additional computational effort. O.C.

A85-19534*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

NUMERICAL SOLUTION OF THE EULER EQUATIONS FOR HIGH-SPEED, BLENDED WING-BODY CONFIGURATIONS

A. MOITRA (NASA, Langley Research Center; Systems and Applied Sciences Corp., Hampton, VA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 11 p. refs (AIAA PAPER 85-0123)

Simulation of high-speed three-dimensional flow about blended wing-body combinations is investigated. A finite-volume explicit scheme with Runge-Kutta time integration is used to solve the compressible Euler equations in order to simulate the flow. The method, augmented by carefully chosen dissipative terms and convergence accelerators such as enthalpy damping and maximum local time-stepping, has been found to be very efficient in solving high-speed flows involving strong shocks. An analytic method for generating the body geometry and an algebraic method for quasi-three-dimensional grid generation are described. Results are presented for various blended wing-body configurations at different Mach numbers and angles of attack. Author

A85-19536#

SURFACE PRESSURE FLUCTUATIONS IN A THREE-DIMENSIONAL SHOCK WAVE/TURBULENT BOUNDARY LAYER INTERACTION

D. K. M. TAN, S. M. BOGDONOFF (Princeton University, Princeton, NJ), and T. T. TRAN American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 12 p. refs (Contract F49620-81-K-0018) (AIAA PAPER 85-0125)

Surface pressure fluctuations have been measured in a three-dimensional shock wave/turbulent boundary layer interaction. The shock wave was generated by a sharp-edged fin set perpendicular to the boundary layer at 10 deg to the flow direction. Tests were conducted at a nominal freestream Mach number of 3. The pressure fluctuations were found to be small in contrast to a two-dimensional compression ramp shock/boundary layer interaction with the same shock strength. This, however, does not suggest that the flow is steady. Cross-correlation analysis suggests some degree of unsteadiness in the shock structure. Contour plots of the space correlations and maxima in cross-correlations were computed. The contours showed the development of the spatial scales and decay rates of the pressure producing structures through the interaction. Author

A85-19538#

SOME THOUGHTS ON THE RANGE/TUNNEL TRANSITION CONTROVERSY

L. E. ERICSSON (Lockheed Missiles and Space Co., Inc., Sunnyvale, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 12 p. refs (AIAA PAPER 85-0127)

The range/tunnel transition controversy is related to the observation that transition occurs earlier in the quiet range than in the noisy wind tunnel. Ericsson (1984) has shown that coupling between vehicle motion and boundary layer transition could provide an explanation for the early transition on the free flight model in a ballistic range. The present investigation is concerned with the existing data base for slender body transition to examine the validity of the concept presented by Ericsson. Local moving wall effects are discussed. According to recent flow visualization results, the spin-induced moving wall velocity generates vortices embedded in the boundary layer, and transition appears to occur through some form of vortex-burst. G.R.

A85-19539#

NUMERICAL STUDY ON THE DYNAMIC STALL PROCESS OF A NACA 0012 AIRFOIL

K. ONO (Nihon University, Tokyo, Japan) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 13 p. refs (AIAA PAPER 85-0128)

The dynamic stall process is numerically simulated on a two-dimensional NACA 0012 airfoil oscillating in pitch at a high incidence angle in a subsonic flow. The formation of the leading-edge separation bubble, as well as its convection along the airfoil surface and shedding into the wake, plays an essential role. The Navier-Stokes equations are to be solved. The time-averaged compressible Navier-Stokes equations with the Baldwin-Lomax turbulence model are solved using the implicitly factored finite-difference algorithm constructed in a body-fitted coordinate system. The same scheme is applied to the laminar compressible Navier-Stokes equations. Qualitative agreement with experimental data is good. The laminar calculation is more promising because small-scale vortices are precisely trapped.

Author

A85-19540#

NUMERICAL SOLUTION OF UNSTEADY VISCOUS FLOW PAST ROTOR SECTIONS

N. L. SANKAR and W. TANG (Georgia Institute of Technology, Atlanta, GA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 11 p. Army-supported research. refs (AIAA PAPER 85-0129)

A compressible Navier-Stokes solver has been developed for unsteady airfoil calculations frequently encountered in rotor applications. This procedure solves the unsteady, compressible Navier-Stokes equations on a body-fitted moving coordinate system in strong conservation form using an ADI procedure. This procedure is capable of treating embedded point and distributed vortices without excessive numerical diffusion, and can capture embedded shocks without overshoots. Numerical results are presented for the following cases to establish the usefulness of this procedure: (1) steady inviscid transonic flow over a NACA 0012 airfoil for a number of Mach numbers and angles of attack, (2) steady subsonic viscous flow past a NACA 0012 airfoil at 0.3 Mach number and 3 million Reynolds number, (3) inviscid transonic flow calculations involving vortex airfoil interaction, and (4) turbulent dynamic stall calculations for a NACA 0012 airfoil. In all cases presented, the results are compared with experimental and other published data.

Author

A85-19541#

INTERRELATED EFFECTS OF PITCH RATE AND PIVOT POINT ON AIRFOIL DYNAMIC STALL

H. E. HELIN (U.S. Air Force Academy; USAF, Frank J. Seiler Research Laboratory, Colorado Springs, CO) and J. M. WALKER (USAF, Frank J. Seiler Research Laboratory, Colorado Springs, CO) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 9 p. refs (AIAA PAPER 85-0130)

Experimental investigations were performed to study energetic dynamic stall vortices and the associated unsteady aerodynamics generated by a pitching NACA 0015 airfoil. The model was pitched from 0 to 60 degrees at constant alpha rates of 460, 920, and 1380 deg/s about its quarter-chord, half-chord, and three quarter-chord positions. Smoke-wire visualization technique and near-surface hot-wires mounted in a staggered array on the airfoil surface were used. It is shown that, as the pitch rate is increased, the angle of attack at which dynamic stall occurs is also increased. Moving the pitch axis toward the trailing edge emulates some of the effects of the increased pitch rate; dynamic stall occurs at correspondingly higher angles of attack, and the large dynamic stall vortex has significant impact on the velocities over the airfoil surface.

L.T.

A85-19542#

CALCULATION OF VISCOUS NOZZLE FLOWS BY THE UNSTEADY METHOD OF CHARACTERISTICS

D. L. MARCUM and J. D. HOFFMAN (Purdue University, West Lafayette, IN) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 14 p. refs (AIAA PAPER 85-0131)

A numerical algorithm based on the unsteady two-dimensional method of characteristics is presented for calculating steady two-dimensional (planar) subsonic/transonic/supersonic viscous (laminar) nozzle flowfields. The Navier-Stokes equations for unsteady two-dimensional (planar) laminar flow are solved. The flowfield unit processes are based on a local network consisting of four bicharacteristics and the pathline. The algorithm is an explicit second-order accurate predictor-corrector procedure. An inverse marching method is employed, wherein the solution grid in physical space is prespecified. Steady flow solutions are obtained as the asymptotic solution in time. Results are presented for a small planar nozzle. The solution obtained by the present method agrees well with the solution obtained by McCormack's explicit method and with experimental data.

Author

A85-19543#

THREE-DIMENSIONALITY IN UNSTEADY FLOW ABOUT A WING

J. N. ADLER and M. W. LUTTGES (Colorado, University, Boulder, CO) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 7 p. refs (Contract AF-AFOSR-81-0037) (AIAA PAPER 85-0132)

Serialized, phase locked, orthogonal view flow visualization was used to characterize the unsteady flow field generated by a finite NACA 0015 wing sinusoidally oscillating through angles of attack centered well beyond the static stall angle. Far inboard, toward the root of the wing, the flow field was dominated by a leading edge vortex similar in phase of initiation, size, and convection velocity to vortices observed in studies modeling an infinite wing. Spanwise smoke movements were associated with the leading edge vortex, indicating three-dimensionality of this nominally two-dimensional structure. Outboard flow was dominated by an unsteady wing tip vortex. An interactive interface region was identified between these well-defined flows. Elicited flow structures were very sensitive to pitching parameters. Visualizations provide evidence that wing tip circulation depended more on leading edge vortex development than on instantaneous angle of attack. These studies indicate the complexity of three-dimensional unsteady flows and the quantification that will be needed to fully characterize such flows.

Author

A85-19556#

THE USE OF PANEL METHODS FOR THE DEVELOPMENT OF LOW-SUBSONIC WALL INTERFERENCE AND BLOCKAGE CORRECTIONS

K. G. BOWCUTT American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 18 p. refs (AIAA PAPER 85-0159)

A method of adjusting two-dimensional wind tunnel data to correct for wall interference is described. The technique employs source and vortex panels and modified kernel functions to represent the model and a separated wake when one is present. Governing equations are defined for the potential flow and the source and vortex singularities which are distributed along the panels. Boundary conditions are imposed at all panel control points and the singularity strengths are calculated. Interferences is then quantified with an implicit wall model and viscous boundary layer effects are treated in terms of the laminar boundary layer, transition, the turbulent boundary layer, and a separated wake. Test runs for an airfoil and a blunt body were compared with experimental data, showing that the method yields accurate interference corrections, pressure distributions, and lift, drag and moment coefficients.

M.S.K.

A85-19562*# United Technologies Research Center, East Hartford, Conn.

A PROCEDURE FOR THE CALCULATION OF SUPERSONIC FLOWS WITH STRONG VISCOUS-INVISCID INTERACTION

M. BARNETT (United Technologies Research Center, East Hartford, CT; Cincinnati, University, Cincinnati, OH) and R. T. DAVIS (Cincinnati, University, Cincinnati, OH) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 9 p. refs
(Contract NGT-36-004-800; NCA2-OR-130-101; N00014-76-C-0364)
(AIAA PAPER 85-0166)

The present paper is concerned with the calculation of strong viscous-inviscid interactions in two-dimensional laminar supersonic flows with and without separation. The equations solved are the so-called parabolized Navier-Stokes equations. The streamwise pressure gradient term is written as a combination of a forward and a backward difference to provide a path for upstream propagation of information. Global iteration is utilized to repeatedly update the pressure field from an initial guess until convergence is achieved. The numerical scheme employed is a new alternating direction explicit (ADE) procedure which is used as an alternative to the more difficult to program multigrid strategy to accelerate convergence. Results are presented for flows past two flat plate related bodies. Author

A85-19563#
NUMERICAL COMPUTATION OF VISCOUS FLOWFIELDS ABOUT MULTIPLE COMPONENT AIRFOILS

D. M. SCHUSTER and L. D. BIRCKELBAW (Lockheed-Georgia Co., Marietta, GA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 8 p. refs
(AIAA PAPER 85-0167)

A method has been developed which solves the time dependent, Reynolds averaged Navier-Stokes equations for compressible flows about multiple component airfoil systems. This method uses a grid patching scheme in conjunction with an Alternating Direction Implicit (ADI) finite difference method to numerically solve the subject equations. An algebraic turbulence model is used to predict turbulence characteristics of the flow. Several cases have been analyzed, and the correlation with experimental data for these cases is very encouraging. Author

A85-19565#
ANALYSIS OF CIRCULATION CONTROL AIRFOILS USING AN IMPLICIT NAVIER-STOKES SOLVER

G. D. SHREWSBURY (Lockheed-Georgia Co., Advanced Flight Sciences Dept., Marietta, GA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 8 p. refs
(AIAA PAPER 85-0171)

The compressible Reynolds time averaged Navier-Stokes equations were used to obtain solutions for both low speed and transonic flows about two-dimensional circulation control airfoils. The governing equations were written in conservation form for a body-fitted coordinate system and solved using an Alternating Direction Implicit (ADI) procedure. A modified algebraic eddy viscosity model was used to define the turbulent characteristics of the flow, including the wall jet flow over the Coanda surface at the trailing edge. Numerical results are compared to experimental data obtained for two circulation control airfoil geometries. Excellent agreement with the experimental results was obtained for both low speed and transonic flow tests. Author

A85-19567*# Purdue Univ., Lafayette, Ind.

THREE DIMENSIONAL AERODYNAMICS OF AN ANNULAR CASCADE IN A NON-UNIFORM INLET FLOW

S. R. MANWARING and S. FLEETER (Purdue University, West Lafayette, IN) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 18 p. NASA-supported research. refs
(AIAA PAPER 85-0174)

Three-dimensional viscous and inviscid numerical analyses are currently being developed to predict the complex flow through turbomachine blade passages. To be of value to the designer, these numerical solutions must be evaluated and subsequent refinements directed by correlating predicted flow fields with data obtained from experiments which model the fundamental three-dimensional flow phenomena inherent in blade rows. This paper describes a series of experiments to provide such data. In particular, the effect of a potential and a rotational inlet flow field on the detailed three-dimensional aerodynamic performance of an extensively instrumented cambered airfoil cascade has been determined at two levels of aerodynamic loading. Data presented quantify the pressure and suction surface static pressure chordwise distributions on the hub, mean, and tip streamlines; the velocity distribution in the cascade aft-passage region; and the cascade exit region flow field. Appropriate data are correlated with predictions. Author

A85-19568#

A NEW ITERATIVE MATRIX SOLUTION PROCEDURE FOR THREE-DIMENSIONAL PANEL METHODS

R. W. CLARK (Douglas Aircraft Co., Long Beach, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 7 p. Research sponsored by the McDonnell Douglas Independent Research and Development Program. refs
(AIAA PAPER 85-0176)

An iterative solution procedure is presented for the large set of linear simultaneous equations for the singularity strengths satisfying the boundary conditions in panel models of three-dimensional flows past bodies. Attention is focused on the Douglas panel method, which describes the flow past the body in terms of a surface source singularity distribution and a normal velocity boundary condition. The acceleration of the solution convergence is achieved by defining a linear combination of earlier approximations after each iteration. The relaxation involves quantifying the residual vector after an iteration, and evaluating it in a simplified form. The process is performed independently from the iteration calculations and considers both the normal velocity and the Kutta condition residuals. Sample convergence histories are provided for a high lift wind and an inlet and compared with those of a Gauss-Seidel scheme. M.S.K.

A85-19569#

A STUDY OF COMPRESSIBLE TURBULENT FREE SHEAR LAYERS USING LASER DOPPLER VELOCIMETRY

H. L. PETRIE (U.S. Army, Missile Laboratory, Redstone Arsenal, AL), M. SAMIMY, and A. L. ADDY (Illinois, University, Urbana, IL) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 11 p. refs
(Contract DAAG29-79-C-0184; DAAG29-83-K-0043)
(AIAA PAPER 85-0177)

An experimental investigation of two-dimensional planar turbulent free shear layers with supersonic freestream Mach numbers is discussed. Three backward facing step flow configurations were investigated in order to gain a detailed knowledge of the mean flow and turbulent field in developing free shear layers with and without an adjacent recirculating flow and a constant pressure separation. Two channel coincident laser Doppler velocimeter (LDV) measurements, surface static pressure measurements, schlieren flow visualization, and surface oil flow visualization were used to study these flows. Author

02 AERODYNAMICS

A85-19570#

SOME FEATURES OF TWO-DIMENSIONAL TURBULENT SEPARATED FLOWS

R. L. SIMPSON (Virginia Polytechnic Institute and State University, Blacksburg, VA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 19 p. refs
(AIAA PAPER 85-0178)

The characteristics of phenomena known to occur in two-dimensional separated flows are reviewed, along with causes for the separations. Attention is given to the experimentally observed features of separating and reattaching turbulent shear flows. The generating mechanisms can be adverse pressure gradients, sharp-edged bluff bodies, backward or forward facing steps, a fence or a rib. The effects of compressibility on separation are noted, and consideration is devoted to transonic, supersonic and stall-induced separated flows. It is shown that the maximum shearing stress is the appropriate scale for the flows, while the reattachment length is required for scaling the streamwise skin friction, upstream-downstream flow direction intermittency, static pressure recovery, and mean square surface pressure fluctuations.

M.S.K.

A85-19571*# Princeton Univ., N. J.

STRUCTURE OF THE WALL PRESSURE FLUCTUATIONS IN A SHOCK-INDUCED SEPARATED TURBULENT FLOW

K. C. MUCK, S. M. BOGDONOFF (Princeton University, Princeton, NJ), and J.-P. DUSSAUGE (Aix-Marseille II, Universite, Marseille, France; Princeton, University, Princeton, NJ) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 13 p. refs
(Contract N60921-83-C-0166; NAGW-240)
(AIAA PAPER 85-0179)

This paper presents the results of an experimental study of the unsteady nature of a shock wave/turbulent boundary layer interaction. The interaction was generated using an unswep compression ramp. The incoming freestream Mach number was 2.9 and the flow was separated at the corner. An array of flush mounted miniature high frequency pressure transducers was used to make multi-channel measurements of the fluctuating wall pressure within the interaction. From the present results, an overall picture of the instantaneous structure of the unsteady shock system (as inferred from the wall pressure signals) can be constructed. The flow ahead of the corner can be considered as composed of two regions, namely the 'intermittent' region where there is essentially a single leading shock which exhibits significant streamwise 'flapping' and spanwise 'rippling', and the separated region where the flow experiences continuous compression.

Author

A85-19572#

MEASUREMENTS OF SEPARATING BOUNDARY LAYER AND WAKE OF AN AIRFOIL USING LASER DOPPLER VELOCIMETRY

A. NAKAYAMA (Douglas Aircraft Co., Long Beach, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 11 p. Research sponsored by the McDonnell Douglas Independent Research and Development Program. refs
(AIAA PAPER 85-0181)

Mean-flow and turbulence measurements have been made in the boundary layer and the wake of a supercritical airfoil model at an angle of attack of 12 deg. The Reynolds number based on chord was 1.2 million and the Mach number was 0.1. The flow included a trailing-edge separation and a laser Doppler velocimeter was used to measure the fluctuating velocities that reverse the direction. Measurements include surface pressure distribution, mean velocity, turbulent stresses, and triple products. Details of these quantities are presented. Some higher-order statistics of turbulence are presented and discussed. Statistics involving the spanwise fluctuations were not obtained.

Author

A85-19573#

COMPUTATION OF UNSTEADY SHOCK-INDUCED VORTEX SEPARATION

S. OBAYASHI, K. KUWAHARA, and H. KUBOTA (Tokyo, University, Tokyo, Japan) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 10 p. refs

(AIAA PAPER 85-0183)

Transonic flows around an NACA0012 airfoil were simulated by directly solving the full Navier-Stokes equations without any turbulence model. The implicit LU factored scheme was used with improved accuracy. The results of unsteady computations without any turbulence model show the clear dependence of the flow on the Reynolds number, and agree qualitatively with experimental observations even at Reynolds numbers over a million. Unsteady shock-induced vortex separation was observed at all the Reynolds numbers. To check the results against experiment, the improved scheme was coupled with the Baldwin-Lomax turbulence model, obtaining excellent agreement with experiment.

Author

A85-19582#

SUBSONIC WING ROCK OF SLENDER DELTA WINGS

P. KONSTADINOPOULOS, D. T. MOOK, and A. H. NAYFEH (Virginia Polytechnic Institute and State University, Blacksburg, VA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 9 p. refs

(Contract N00014-75-C-0381; NR PROJECT 061-201)

(AIAA PAPER 85-0198)

Experiments which have been conducted to investigate the self-excited motion of a flat delta wing, which is free to roll about an axis parallel to its midspan chord, are presently simulated numerically. The solution obtained on the basis of both an unsteady vortex lattice method for aerodynamic loads and an integration of the equation of motion by means of a prediction-correction scheme provides complete histories of the motions of the flowfield and the wing simultaneously, fully accounting for dynamic-aerodynamic interaction. It is found that at sufficiently high incidence, small disturbances introduced into the flowfield grow and induce wing rock. The simulation shows the influence of the experimental parameters, and provides an explanation for differences in the observations.

O.C.

A85-19587#

UNSTEADY AERODYNAMICS OF AN AIRFOIL ENCOUNTERING A PASSING VORTEX

J. C. WU, N. L. SANKAR, and T. M. HSU (Georgia Institute of Technology, Atlanta, GA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 9 p. refs

(Contract AF-AFOSR-82-0108; DAAG29-82-K-0094)

(AIAA PAPER 85-0203)

The problem of vortex airfoil interaction is analyzed using three approaches: (1) incompressible flow calculations using conformal mapping techniques, (2) incompressible viscous flow calculations using the vorticity-stream function formulation, and (3) compressible inviscid transonic flow calculations using the Euler equations. In the incompressible flow calculations the aerodynamic loads experienced by the airfoil are decomposed into components associated with distinct physical processes using a generalized aerodynamic forces and moments theory. Numerical results are presented for a NACA 0012 airfoil at zero angle of attack encountering a vortex of strength $-0.20 V c$ at zero and 0.8 Mach number and for a NACA 64A006 airfoil at a free stream Mach number of 0.85 and zero angle of attack encountering a vortex of strength $-0.2 V c$. Results are compared with available theoretical and experimental data.

Author

A85-19588*# Stanford Univ., Calif.

CIRCULATION CONTROL AIRFOILS - PAST, PRESENT, FUTURE

N. J. WOOD (Stanford University, Stanford, CA) and J. N. NIELSEN (NASA, Ames Research Center, Moffett Field, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 22 p. refs (AIAA PAPER 85-0204)

This paper presents a review of circulation control technology, its history, status and areas for further research and development. A brief description of the basic performance characteristics of circulation control airfoils are presented together with a more detailed discussion of some of the more important aerodynamic parameters dependencies. The unique capability of the airfoils to develop high lift coefficients independent of incidence over a range of operating conditions is demonstrated. Consideration is also given to the various stall conditions that have been experimentally observed and to the various theoretical formulations that have been attempted to explain these phenomena. Author

A85-19589#

PREDICTION OF SUBSONIC/TRANSONIC SEPARATED FLOW ABOUT AIRFOILS

F. TAVERNA (Grumman Aerospace Corp., Bethpage, NY) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 10 p. refs (AIAA PAPER 85-0205)

A computational method is presented for the analysis of subsonic and transonic flow about airfoils which might have substantial separation. The objective of this effort was to eliminate the past requirement of using different analysis codes depending on the flow conditions. The inviscid flow solver comes from the Korn-Garabedian airfoil analysis code. This has been combined with an inverse integral compressible turbulent boundary-layer method. Results at both subsonic and transonic speeds are compared to experimental data for a NACA 0012 airfoil. Future plans are discussed. Author

A85-19590*# Illinois Univ., Urbana.

A CLASS OF AIRFOILS HAVING FINITE TRAILING EDGE PRESSURE GRADIENTS

A. I. ORMSBEE (Illinois, University, Urbana, IL) and M. D. MAUGHMER (Pennsylvania State University, University Park, PA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 9 p. refs (Contract NAG1-76) (AIAA PAPER 85-0206)

Some new developments relevant to the design of single-element airfoils using potential flow methods are presented. In particular, the ramifications of the unbounded trailing edge pressure gradients generally present in the potential flow solution for the flow over an airfoil are examined, and the conditions necessary to obtain a class of airfoils having finite trailing edge pressure gradients developed. The incorporation of these conditions into the inverse method of Eppler for the design of low-speed airfoils is discussed, and designs generated using the modified scheme are presented for consideration. A detailed viscous analysis of one of these airfoils demonstrates a significant reduction in the strong inviscid-viscid interactions generally present near the trailing edge. These reductions offer the possibility of improved airfoil performance, as well as the possibility of improved accuracy in the methods of airfoil design and analysis. Author

A85-19591*# Rensselaer Polytechnic Inst., Troy, N. Y.

SUPERCritical AIRFOIL DRAG REDUCTION BY PASSIVE SHOCK WAVE/BOUNDARY LAYER CONTROL IN THE MACH NUMBER RANGE .75 TO .90

H. T. NAGAMATSU (Rensselaer Polytechnic Institute, Troy, NY), R. V. FICARRA (Grumman Aerospace Corp., Bethpage, NY), and R. DYER American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 8 p. refs

(Contract NAG1-330)

(AIAA PAPER 85-0207)

Airfoils operating in the transonic region are subject to large increases in drag due to shock wave/boundary layer interactions. The concept of passive shock wave/boundary layer control seeks drag reduction by placing a thin cavity with a porous top surface at the airfoil chordwise position where a shock wave would normally occur. The higher pressure behind the shock wave circulates flow through the cavity to the lower pressure ahead of the shock wave. The effects from this circulation prevent boundary layer separation and reduce entropy increases through the shock wave. In this investigation this concept is studied at a freestream Mach number range of .75 and .90. The Mach number distributions over the model, the wake impact pressure surveys used to determine profile drag and schlieren photographs for 2.8 percent porosity and solid airfoil cases are presented and compared. Results indicate that the profile drag coefficient can be reduced by as much as 40 percent through the use of this passive drag control system. Author

A85-19592#

A FOURIER TRANSFORM METHOD FOR CALCULATING VELOCITY PROFILES ON AIRFOILS

D. E. WILSON (Texas, University, Austin, TX) and W. J. TEDESCHI American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 7 p. refs

(AIAA PAPER 85-0208)

A new method has been developed for predicting the unsteady, inviscid, incompressible flow field around a two-dimensional airfoil inside a porous-wall wind tunnel. Using Fourier Transform techniques, the inviscid flow field is solved in a unique manner to yield an approximate closed form integral solution. The solution form is that of a Fredholm integral equation of the second kind and is evaluated using numerical quadrature. Comparisons with other theoretical methods and experimental data are then presented. Author

A85-19593*# Grumman Aerospace Corp., Bethpage, N.Y.

PREDICTION OF HIMAT RPRV COMPONENT INTERFERENCE EFFECTS AT TRANSONIC SPEEDS

J. LAIOSA (Grumman Aerospace Corp., Bethpage, NY) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 10 p. refs (Contract NAS2-11424)

(AIAA PAPER 85-0213)

Detailed surface flow field analyses of the NASA Highly Maneuverable Aircraft Technology Remotely Piloted Research Vehicle (HiMAT RPRV) are described. Computational predictions are provided by a nonlinear finite difference transonic wing-body code. Component interference effects are obtained through modifications in lifting surface twist and camber boundary conditions. Complex aircraft interactions created by wing-tip fins, landing gear, and lower surface wing actuator fairings are included. Lifting surface viscous flow effects are modeled using a two-dimensional 'strip' boundary layer method. Correlations with flight test data presented demonstrate the high degree of accuracy achieved for this realistic aircraft configuration. This methodology and approach appears to be generally applicable to other multisurface configurations. Author

A85-19611*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

APPLICATION OF AXISYMMETRIC ANALOGUE FOR CALCULATING HEATING IN THREE-DIMENSIONAL FLOWS

H. H. HAMILTON, K. J. WEILMUNSTER (NASA, Langley Research Center, Space Systems Div., Hampton, VA), and F. R. DEJARNETTE (North Carolina State University, Raleigh, NC) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 16 p. refs (AIAA PAPER 85-0245)

A rapid, approximate method has been developed for calculating the heating rates on three-dimensional vehicles such as the Space Shuttle Orbiter and other advanced reentry configurations. The method is based on the axisymmetric analogue for three-dimensional boundary layers. It uses information obtained from a three-dimensional inviscid flowfield solution, such as HALIS, to calculate inviscid surface streamlines along which approximate heating rates are calculated independent of what happens along other streamlines. Three-dimensional effects are included through the metric coefficient that describes the divergence or convergence of streamlines. Boundary-layer edge properties are obtained from the inviscid flowfield solution by interpolating in the inviscid flowfield at a distance equal to the boundary-layer thickness away from the wall. This accounts, approximately, for the variable boundary-layer edge entropy. Using this method, heating calculations can be made along a typical streamline in a few seconds. This method has been used to accurately predict heating rates for simple shapes such as a spherically blunted cone and more complex shapes such as the Shuttle Orbiter for a variety of wind-tunnel and flight conditions. A unique feature of the method is its ability to accurately predict heating rates on the Shuttle Orbiter wing. Author

A85-19614#

A SIMPLE ANALYTICAL METHOD FOR PREDICTING AXISYMMETRIC TURBULENT JET FLOWFIELDS IN A FREESTREAM

C.-W. CHU (Northrop Corp., Aircraft Div., Hawthorne, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 10 p. refs (AIAA PAPER 85-0251)

A simple global analysis of the effect of freestream or composition on centerline flow property decays in a turbulent jet are presented. A simple correlation between velocity and total temperature decays in turbulent subsonic and perfectly expanded supersonic jets is derived. An analytic method for calculating the jet half radii for constant-pressure self-similar turbulent jets with and without a freestream is developed. Together, these analyses form a method for predicted axisymmetric turbulent flowfields of subsonic and perfectly expanded supersonic jets statically or in a freestream. An example of a turbulent jet flowfield is given showing excellent agreement with test data. C.D.

A85-19617*# Continuum Dynamics, Inc., Princeton, N. J. **SCALING LAWS FOR TESTING OF HIGH LIFT AIRFOILS UNDER HEAVY RAINFALL**

A. J. BILANIN (Continuum Dynamics, Inc., Princeton, NJ) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 11 p. refs (Contract NASA ORDER L-71488-B) (AIAA PAPER 85-0257)

The results of studies regarding the effect of rainfall about aircraft are briefly reviewed. It is found that performance penalties on airfoils have been identified in subscale tests. For this reason, it is of great importance that scaling laws be developed to aid in the extrapolation of these data to fullscale. The present investigation represents an attempt to develop scaling laws for testing subscale airfoils under heavy rain conditions. Attention is given to rain statistics, airfoil operation in heavy rain, scaling laws, thermodynamics of condensation and/or evaporation, rainfall and airfoil scaling, aspects of splash back, film thickness, rivulets, and flap slot blockage. It is concluded that the extrapolation of airfoil

performance data taken at subscale under simulated heavy rain conditions to fullscale must be undertaken with caution. G.R.

A85-19621*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

NUMERICAL SOLUTION OF THE FULL-POTENTIAL EQUATION FOR ROTORS AND OBLIQUE WINGS USING A NEW WAKE MODEL

I.-C. CHANG (NASA, Ames Research Center, Moffett Field, CA) and C. TUNG (U.S. Army, Aeromechanics Laboratory, Moffett Field, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 7 p. refs (AIAA PAPER 85-0268)

A three-dimensional, full-potential, quasi-steady code TFAR1 is proposed for calculating the transonic flow past a lifting helicopter rotor blade and oblique wing. The TFAR1 uses a two-dimensional nonlinear wake-model that allows a jump in velocity potential to propagate with the local fluid flow in the wake. Rotor calculations were made for a single blade at an advance ratio of 0.3, a rotational tip Mach number of 0.7, and at 0-degree incidence. A 1/7-scale model of the Cobra Operational Load Survey (OLS) rotor blade is calculated, and the pressure distributions are compared to the measurements for azimuth angles 0, 30, 60, 90, 120, and 150 degrees at the 95 percent spanwise station of the OLS blade. Furthermore, an oblique wing with Korn airfoil was calculated at the high transonic free-stream Mach number of 0.9791, zero incidence, and yaw angle of 40 degrees. The TFAR1, coupled with a helicopter performance code CAMRAD (Johnson, 1981), provides a full-potential code for calculating the entire flow field for a multiple-bladed rotor in transonic lifting forward flight. L.T.

A85-19622#

A COMPARISON BETWEEN THEORETICAL AND EXPERIMENTAL FLOW FIELDS OF AN AIRFOIL WITH DEFLECTED SPOILER

C. S. LEE and S. BODAPATI (Joint Institute for Aeronautics and Acoustics, Stanford, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 11 p. Research supported by the Boeing Co. refs (AIAA PAPER 85-0269)

A two-dimensional vortex tracing method is developed to simulate the unsteady flow field of an airfoil with deflected spoiler. The airfoil-spoiler geometry is represented by vortex panels and the wake is modeled by discrete point vortices with viscous cores. Average velocities are taken at the sharp edges to avoid singularities. Merging schemes are used to reduce the vortices in the wake. The surface pressure distributions, mean velocity profiles and turbulent stresses in the wake, and Strouhal number are calculated and compared with the experimental results for various angles of attack and spoiler deflection. The comparisons show that the vortex method describes this unsteady flow field reasonably well. Author

A85-19624#

AERODYNAMIC PREDICTION OF ELLIPTICALLY-SHAPED MISSILE CONFIGURATIONS USING COMPONENT BUILD-UP METHODOLOGY

S. R. VUKELICH (McDonnell Douglas Astronautics Co., St. Louis, MO) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 8 p. refs (AIAA PAPER 85-0271)

Methods for the aerodynamic design of elliptically shaped cross section configurations using component build-up techniques are described. Since these techniques are primarily for use in the preliminary or conceptual design environments, they are easily applied and use methods which have been proven for conventional missile shapes. A new method for accounting for fin-body interference is developed, and its accuracy is compared to experiment. Also included are comparisons to experiment for elliptical cross section body alone, winged elliptical bodies, and elliptical bodies with multiple lifting surfaces. Although the methods

are applicable to a wide range of preliminary design configurations, a few problem areas remain; these are identified. Author

A85-19628*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

SUBSONIC PRESSURE DISTRIBUTIONS NEAR A WING-FIN JUNCTURE ON A SUPERSONIC ARROW-WING CONFIGURATION WITH WING-MOUNTED VERTICAL FIN

J. K. HUFFMAN and C. H. FOX, JR. (NASA, Langley Research Center, Hampton, VA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 11 p. refs (AIAA PAPER 85-0276)

A generic supersonic arrow-wing configuration has been extensively studied to develop a consistent experimental data base to aid in verifying analytical prediction methods. One of the wing configurations studied was a twisted and cambered wing with wing-mounted vertical fins and trailing-edge flaps. The pressure data obtained on that configuration was limited in the wing-fin juncture region, and no pressures were obtained on the fin itself. However, detailed data in the juncture region and on the fin are essential to check out the analytical prediction methods. Therefore, the model was modified to provide details of the juncture pressure field as well as pressures on the fin. The results of this experimental investigation showed that the addition of a fin helped improve the wing pressure distribution outboard of the fin. Deflection of the trailing-edge flap did not adversely affect this trend. The pressure distributions on the vertical fin were generally affected more by change in angle of attack than by flap deflection. The spanwise pressure distribution on the fin itself indicated a load reversal with angle of attack. Author

A85-19629#
EFFECTS OF COVERING CONFIGURATIONS ON ULTRALIGHT WING AERODYNAMICS

J. F. MARCHMAN, III and R. M. FRENCH (Virginia Polytechnic Institute and State University, Blacksburg, VA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 7 p. (AIAA PAPER 85-0277)

Wind tunnel tests were conducted to determine the influence of wing covering configuration and material flexibility on the aerodynamics of a typical ultralight aircraft wing design. Configurations examined included full surface covering, covering of only the upper wing surface and covering the upper surface plus partial covering of the lower surface. Covering materials included flexible and heat shrunk surfaces as well as a rigid metal surface. The results of the work show substantial differences in some of the configurations and should serve as a warning to the builder of ultralight aircraft to use extreme caution in modifying wing designs by such actions as substituting full surface covering for partial surface covering of the wing. Author

A85-19630#
AERODYNAMICS OF AN ASPECT RATIO 8 WING AT LOW REYNOLDS NUMBERS

J. F. MARCHMAN, III (Virginia Polytechnic Institute and State University, Blacksburg, VA) and A. A. ABTAHI American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 10 p. (AIAA PAPER 85-0278)

Wind tunnel tests were conducted on a three-dimensional wing of aspect ratio 8 at chord based Reynolds numbers between 70,000 and 300,000. Lift forces and pitching moments were measured using a strain gauge force balance and drag obtained through the strain gauge method and the momentum deficit method. The results of the two methods are compared. Two different flow visualization techniques were used to gain additional understanding of the flow phenomena occurring. The presence of a hysteresis loop in stall is demonstrated. Wingtip effects are found to be confined to the tip region and there is no significant influence on the laminar separation bubble due to the three-dimensionality of the flow. Author

A85-19631*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

STUDY OF WINGLETS APPLIED TO BIPLANES

P. D. GALL (NASA, Langley Research Center, Hampton, VA) and H. C. SMITH (Pennsylvania State University, University Park, PA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 7 p. refs (AIAA PAPER 85-0279)

This paper examines, both theoretically and experimentally, the possibility of improving the aerodynamic characteristics of a biplane configuration by adding winglets. Theoretical calculations show good agreement with experiment in predicting inviscid drag due to lift. Theoretical and experimental results indicate that the addition of winglets to an optimized biplane configuration can increase the ideal efficiency factor by up to 13 percent, as well as increasing the lift-curve slope and maximum lift coefficient. A theoretical analysis comparing the biplane with an optimized winglet to an equivalent monoplane indicates that the biplane has the potential for a 6.4-percent increase in $L/D(\max)$, and 13-percent increase in CL to the $3/2$ -power/ $C(D)$, the classical endurance parameter. Author

A85-19632#
LINEARIZED POTENTIAL FLOW ANALYSIS OF COMPLEX AIRCRAFT CONFIGURATIONS BY HISSS, A HIGHER ORDER PANEL METHOD

L. FORNASIER (Messerschmitt-Boelkow-Blohm GmbH, Munich, West Germany) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 8 p. refs (AIAA PAPER 85-0281)

Following the higher-order approach pioneered by the PANAIR method, a new panel method - called HISSS - is presently being developed at MBB for the calculation of sub/supersonic linearized potential flows about arbitrary three-dimensional configurations. In this investigation, published PANAIR results have been used to validate HISSS capabilities in the analysis of complex aircraft configurations. Comparison of surface pressures, forces and moments and flowfield characteristics - presented for two aircraft configurations demonstrates the effectiveness of the present method as an engineering tool for the computer aided aerodynamic design of aircraft configurations at subsonic and supersonic speeds. Author

A85-19633#
APPLICATION OF CONTINUOUS VORTICITY PANELS TO GENERAL UNSTEADY TWO-DIMENSIONAL LIFTING FLOWS

M. J. KIM and D. T. MOOK (Virginia Polytechnic Institute and State University, Blacksburg, VA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 13 p. refs (AIAA PAPER 85-0282)

Continuous vorticity panels are used to model general unsteady two-dimensional lifting flows. The geometry of the airfoil is approximated by a series of short straight segments having end points that lie on the actual surface. The no-penetration condition is imposed at the mid-point of each segment and at discrete times. The wake is simulated by a system of discrete vortex cores, which move at the local particle velocity. At each time step a new core is placed at the trailing edge and the condition of constant circulation around wing and wake is imposed. Because the system is over-determined, an optimization scheme is used to obtain simultaneously the unknown values of the surface velocity at the end points of the segments and the unknown value of the circulation around the core at the trailing edge. Comparisons are made with known exact solutions and wind tunnel data for one and two component airfoils in steady flow, and with other computed results and one experiment for unsteady flow. The present approach provides an attractive alternative to those developed earlier, being easy to formulate, easy to use, and very accurate. Author

A85-19634#

CALCULATION OF STEADY FLOW ABOUT PROPELLERS BY MEANS OF A SURFACE PANEL METHOD

J. L. HESS and W. O. VALAREZO (Douglas Aircraft Co., Long Beach, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 9 p. Navy-sponsored research. refs (AIAA PAPER 85-0283)

A general method for making detailed calculations of flow about propellers with centerbodies has been constructed by adapting a surface panel method. Apparently this is the first method capable of obtaining reliable surface pressure distributions in the blade leading-edge region. New features of the program include input of an axisymmetric nonuniform onset flow, provision for blade symmetry, and generation of the helical wake, including a special far-wake approximation. Calculated blade pressure distributions and propeller efficiencies agree well with experimental data for the two propellers that have been considered. Several sample calculations have been included. Author

A85-19635#

OPTIMIZED DISCRETE-SINGULARITY REPRESENTATION OF AXISYMMETRIC BODIES

J. C. JANIKOWSKY (U.S. Naval Postgraduate School, Monterey, CA; U.S. Navy, Norfolk Naval Shipyard, Portsmouth, VA) and T. SARPKAYA (U.S. Naval Postgraduate School, Monterey, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 9 p. refs (AIAA PAPER 85-0284)

A rational methodology has been developed whereby three-dimensional axial singularities may be used to represent the potential flow past an axisymmetric body of arbitrary profile at angles of attack. For this purpose the strength and position of the singularities along the axis of the body and the position and number of the control points on the surface of the body were optimized so as to minimize the normal velocity through the use of the method of least squares and the Automated Design Synthesis optimization technique. For flows at angle of attack, the axial and cross flow potentials have been superimposed to obtain the resulting three-dimensional velocity and pressure distributions. The results have shown that the use of two types of optimization in the determination of the strength and position of the singularities yields the desired body shape and the flow characteristics with excellent accuracy. A comprehensive computer code has been developed to enable one to calculate most of the practically significant body shapes. Author

A85-19641*# North Carolina State Univ., Raleigh.

EULER CALCULATIONS FOR MULTIELEMENT AIRFOILS USING CARTESIAN GRIDS

D. K. CLARKE, H. A. HASSAN (North Carolina State University, Raleigh, NC), and M. D. SALAS (NASA, Langley Research Center, Theoretical Aerodynamics Branch, Hampton, VA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 9 p. refs (Contract NCC1-22) (AIAA PAPER 85-0291)

A finite volume formulation for the Euler equations using Cartesian grids is presented and used to study complex two-dimensional configurations. The formulation extends methods developed for the potential equation to the Euler equations. Results using this approach for single element airfoils are shown to be competitive with and as accurate as other methods that employ mapped grids. Further, it is demonstrated that this method provides a simple and accurate procedure for solving flow problems involving multielement airfoils. Author

A85-19642*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

NUMERICAL SOLUTION OF THE TWO-DIMENSIONAL EULER EQUATIONS BY SECOND-ORDER UPWIND DIFFERENCE SCHEMES

J. Y. YANG (NASA, Ames Research Center, Moffett Field, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 12 p. refs (AIAA PAPER 85-0292)

Two time-level, five-point explicit and implicit upwind difference schemes based on the characteristic flux difference splitting concept have been developed for the two-dimensional Euler equations. The method is conservative, second-order accurate in time and space, and general coordinate systems are used to treat complex geometries. Nonlinear flux limiters are employed to yield oscillation free sharp shock profiles. Upstream interpolation is used to yield a class of higher-order upwind schemes which closely mimic the locally one-dimensional method of characteristics (with fixed time intervals) through operator splitting. Numerical results have been obtained for a plane shock reflection and for flow over a circular arc in a channel. Characteristics of upwind TVD schemes, as applied to two-dimensional flows with embedded shocks are discussed. Author

A85-19643#

MULTIGRID SOLUTION OF THE EULER EQUATIONS USING IMPLICIT SCHEMES

A. JAMESON and S. YOON (Princeton University, Princeton, NJ) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 10 p. refs (AIAA PAPER 85-0293)

A multigrid method for implicit schemes of the approximate factorization type is described. The application of the method coupled with an Alternating Direction Implicit scheme to the solution of the Euler equations for transonic flow over an airfoil has resulted in very rapid convergence. The number of time steps required to reach a steady state is reduced by an order of magnitude by the introduction of multiple grids. Author

A85-19644*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

A RELAXATION APPROACH TO PATCHED-GRID CALCULATIONS WITH THE EULER EQUATIONS

M. M. RAI (NASA, Ames Research Center, Moffett Field, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 19 p. refs (AIAA PAPER 85-0295)

A conservative zonal-boundary condition that was used with explicit integration schemes is extended to implicit, upwind, relaxation schemes; in particular to the Osher scheme. The rate of convergence was found to increase considerably with the use of the implicit, relaxation-zonal scheme when compared to the explicit scheme. The relaxation-zonal scheme has also been used in a time-accurate mode. Results demonstrating the time accuracy of the scheme and the feasibility of performing calculations in cases where some parts of the given system move relative to others (for example, rotor-stator configurations) are presented. Author

A85-19648*# Princeton Univ., N. J.

THE DISTORTION OF A SUPERSONIC TURBULENT BOUNDARY LAYER BY BULK COMPRESSION AND SURFACE CURVATURE

A. J. SMITS (Princeton University, Princeton, NJ) and M. JAYARAM American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 10 p. refs (Contract NAGW-240) (AIAA PAPER 85-0299)

An experimental investigation is conducted of the effects of bulk compression and streamline curvature on a turbulent supersonic boundary layer whose incoming Mach number is 2.87. Two different, constant-radius curved wall models were used; the

total turning angle in both cases was fixed at 8 deg. While the amplification of the normal stress was approximately the same in both models, the amplification of the shear stress was greater in the one with $\delta(o)/R$ value 0.1 than in the model with a value of 0.02. The flow over the latter model appears to be especially complex. O.C.

A85-19649#

A NAVIER-STOKES INVESTIGATION OF A CIRCULATION CONTROL AIRFOIL

H. A. BERMAN (David W. Taylor Naval Ship Research and Development Center, Bethesda, MD) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 10 p. refs (AIAA PAPER 85-0300)

A time-dependent, finite difference method is used in solving the complete, two-dimensional Reynolds-averaged Navier-Stokes equations for the turbulent flow about a circulation-control airfoil. The conditions simulated numerically are based on a transonic wind tunnel experiment, with the data points investigated corresponding to conditions immediately before stall. Numerical results obtained for the flow field over the aft 50 percent of the airfoil are in qualitative agreement with the experimental data, and furnish insights into the fluid dynamics of circulation control airfoils. O.C.

A85-19650*# Maryland Univ., College Park.

A STUDY OF THE EFFECTS OF NUMERICAL DISSIPATION ON THE CALCULATION OF SUPERSONIC SEPARATED FLOWS

G. KURUVILA and J. D. ANDERSON, JR. (Maryland, University, College Park, MD) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 16 p. refs (Contract NCC1-41) (AIAA PAPER 85-0301)

An extensive investigation of the effect of numerical dissipation on the calculation of supersonic, separated flow over a rearward-facing step is carried out. The complete two-dimensional Navier-Stokes equations are solved by means of McCormack's standard explicit, unsplit, time-dependent, finite difference method. A fourth-order numerical dissipation term is added explicitly. The magnitude of this term is progressively varied, and its consequences on the flowfield calculations are identified and studied. For a cold-wall, heat transfer case, numerical dissipation had a major effect on the results, particularly in the separated region. However, rather dramatically for an adiabatic wall case, numerical dissipation had virtually no effect on the results. The role of grid size on both the influence of numerical dissipation, and on the overall accuracy of the separated flow solutions is discussed. Author

A85-19651*# National Aeronautics and Space Administration, Langley Research Center, Hampton, Va.

SPECTRAL METHODS FOR MODELING SUPERSONIC CHEMICALLY REACTING FLOW FIELDS

J. P. DRUMMOND, T. A. ZANG (NASA, Langley Research Center, High-Speed Aerodynamics Div., Hampton, VA), and M. Y. HUSSAINI (NASA, Langley Research Center, Institute for Computer Applications in Science and Engineering, Hampton, VA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 11 p. refs (AIAA PAPER 85-0302)

A partial implicit numerical algorithm has been developed for solving the equations describing chemically reacting supersonic flows. The algorithm employs a two-stage Runge-Kutta method for integrating the equations in time and a Chebyshev spectral method for integrating the equations in space. The accuracy and efficiency of the new technique have been assessed by comparison with an existing implicit finite-difference procedure for modeling chemically reacting flows. The comparison showed that the new procedure yielded equivalent accuracy on much coarser grids as compared to the finite-difference procedure with resultant significant gains in computational efficiency. Author

A85-19652#

CRITICAL LAYER CONCEPT RELATIVE TO HYPERSONIC BOUNDARY LAYER STABILITY

H. T. NAGAMATSU (Rensselaer Polytechnic Institute, Troy, NY) and R. E. SHEER, JR. (GE Research and Development Center, Schenectady, NY) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 9 p. refs (AIAA PAPER 85-0303)

At hypersonic Mach numbers, the critical layer height approaches the outer edge of laminar boundary layer and the phase velocity of the disturbance is subsonic relative to the free stream velocity. Small disturbances become amplified to form turbulent bursts in the transition region for subsonic to hypersonic laminar boundary layers. The Orr-Sommerfeld equation for the stability of the boundary layer is valid for hypersonic boundary layers. Wall cooling and favorable pressure gradient effects on the stability of the boundary layer become small at hypersonic Mach numbers because of the outward movement of the critical layer with Mach number. Author

A85-19653*# Grumman Aerospace Corp., Bethpage, N.Y.

THE COMPUTATIONAL TREATMENT OF SUPERSONIC WAKE FLOWS IN INCOREL

M. J. SICLARI (Grumman Research and Development Center, Bethpage, NY) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 13 p. refs (Contract NAS1-16758) (AIAA PAPER 85-0304)

Supersonic wake flows are computed in both conical and three-dimensional full potential flows by modeling the wake as a planar cut with a potential discontinuity. Continuity of pressure is satisfied exactly on the wake cut by computing the necessary potential jump at each wake cut grid point. In the conical wake problem, the jump in potential vanishes in the crossflow symmetry plane. Generally, good correlation is achieved for fully three-dimensional wake flows with the planar wake approximation. Matching pressures in the isolated wake flow leads to small variations in the spanwise jump in potential. On the other hand, a small variation in the jump in potential near the wing tip flow can lead to a significant loading in the wake flow if the pressures are not matched. V.L.

A85-19686*# National Aeronautics and Space Administration, Langley Research Center, Hampton, Va.

DETERMINATION OF RAREFIED-FLOW AERODYNAMICS OF THE SHUTTLE ORBITER FROM FLIGHT MEASUREMENTS ON STS-6 AND STS-7

R. C. BLANCHARD and G. M. BUCK (NASA, Langley Research Center, Space Systems Div., Hampton, VA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 11 p. refs (AIAA PAPER 85-0347)

This report presents the flight data results from the High Resolution Accelerometer Package (HiRAP) experiment on the sixth and seventh Shuttle missions (i.e. STS-6 and STS-7). The data have been reduced to produce aerodynamic force coefficients, principally L/D in the rarefied flow regime. Also, a technique is used to extract approximate body-axis aerodynamic coefficients from the flight data. Comparisons of the rarefied transition flow aerodynamic behavior between the two sets of flight data indicate differences, primarily in the free-molecule flow coefficients; i.e. STS-7 shows a free-molecule flow behavior which correlates with diffuse surface reflection conditions, while STS-6 does not. The data have also been used to estimate the density profiles in the atmosphere. The atmospheric density is generated from 60 to 160 km from each flight. The density profiles produced have a primary wave structure and differences are observed between the two sets of flight data. A new rarefied transitional flow aerodynamic bridging formula has been generated from the flight data. Comparisons with the flight bridging formula and existing Monte Carlo and wind-tunnel data are made. Author

02 AERODYNAMICS

A85-19688#

REGARDING PARAMETRIC INVESTIGATIONS OF SLENDER CONE NOSE BLUNTNESS EFFECTS

L. E. ERICSSON (Lockheed Missiles and Space Co., Inc., Sunnyvale, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 7 p. refs
(AIAA PAPER 85-0349)

The well documented effect of nose bluntness on the hypersonic aerodynamics of slender cones is analyzed. It is shown that the combined effect of nose bluntness and semi-cone angle can be represented by a scaling parameter, and that the scaling concept can be extended to include the effects of moderate angles of attack. Using this generalized scaling concept it can be demonstrated that the approximation on which it is based introduces errors that are substantially smaller than the differences between tests in different wind tunnels. Thus, one can conclude that further parametric investigations of the effect of nose bluntness on hypersonic slender cone aerodynamics are not needed.

Author

A85-19689*# Vigyan Research Associates, Inc., Hampton, Va.
AN ATTACHED FLOW DESIGN OF A NONINTERFERING LEADING EDGE EXTENSION TO A THICK DELTA WING

F. GHAFARI (Vigyan Research Associates, Inc., Hampton, VA) and J. E. LAMAR (NASA, Langley Research Center, Hampton, VA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 10 p. refs
(AIAA PAPER 85-0350)

The analytical procedure presented for leading edge extension (LEE) determination, in keeping with such design criteria as noninterference at the wing design point, is applied to thick delta wings. The LEE device thus defined is to be mounted on a wing along a dividing stream surface that is associated with an attached flow design lift coefficient greater than zero. The delta wing in question is of twisted and cambered type. It is demonstrated that span reductions for the candidate LEEs has the most detrimental effect on overall aerodynamic efficiency, irrespective of area or shape.

O.C.

A85-19690#

PASSIVE CONTROL EFFECTS ON FLOW SEPARATION AROUND A PROTUBERANCE AT HIGH SUBSONIC SPEED

F. L. SMITH (USAF, Weapons Laboratory, Kirtland AFB, NM), D. C. CHOU (New Mexico, University, Albuquerque, NM), and R. K. DE JONCKHEERE American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 8 p. refs
(AIAA PAPER 85-0351)

Unsteady surface pressure and oil flow data have been collected for several fairing configurations surrounding a blunt protuberance at high subsonic speed. The goal was to reduce the unsteadiness of the separated flow region around the blunt body by passive flow control techniques to enhance the optical propagation quality. Unsteady pressure data in the form of rms pressure fluctuations, power spectral density and cumulative power plots, and flow visualization data are presented for some turret/fairing configurations tested at Mach numbers of 0.55, 0.65, and 0.75. From the analysis of the unsteady pressure data and flow visualization from the oil flow photographs, it is evident the surface pressure fluctuation levels can be dramatically reduced through passive flow control. This suggests the unsteadiness in the separated wake and shear layer regions around the protuberance are also reduced, which means the optical transmission quality of the flow field is improved.

Author

A85-19691#

THE INFLUENCE OF CAMBER VARIATION ON THE AERODYNAMICS OF CIVIL TRANSPORT AIRCRAFT

J. SZODRUCH (Messerschmitt-Boelkow-Blohm GmbH, Bremen, West Germany) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 7 p. Research supported by the Bundesministerium fuer Forschung und Technologie. refs
(AIAA PAPER 85-0353)

The paper discusses results of two research programs which are concerned with camber modifications on wings of existing aircraft configurations. The experimental investigations revealed improvements in buffet boundary, in lift-to-drag ratio and wing root bending moment. These results are used to formulate a new wing concept with variable camber during cruise flight.

Author

A85-19692#

AFTERBODY DRAG REDUCTION BY VORTEX GENERATORS

W. CALARESE, W. P. CRISLER, and G. L. GUSTAFSON (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 8 p. refs
(AIAA PAPER 85-0354)

An experimental investigation was performed on the effects of vortex generators on the total drag of a 1/72 scale model of a C-130 aircraft. Vortex generators energize low energy boundary layer flow and delay separation in regions of high adverse pressure gradients. The C-130 aircraft model was selected for the experiment because of its highly up-swept afterbody where the flow is characterized by very high adverse pressure gradients. Results show an appreciable drag reduction for some of the configurations tested.

Author

A85-19696*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.

A THREE-DIMENSIONAL NAVIER-STOKES/EULER CODE FOR BLUNT-BODY FLOW COMPUTATIONS

C. P. LI (NASA, Johnson Space Center, Houston, TX) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 21 p. refs
(AIAA PAPER 85-0361)

The formulation computation method of an improved version of the three-dimensional Navier-Stokes/Euler computation algorithm of Li (1981) for the numerical simulation of blunt-body reentry flows are discussed, and results for five sample problems are presented graphically. The vector notation of the coordinate systems is defined; the governing equations are presented in full; the Jacobian matrices and damping terms of the factorization technique (based on the alternating-direction implicit procedure of Beam and Warming, 1978) are explained; and the capabilities, limitations and proper use of the code are summarized. Examples presented include the equilibrium-flow problem for Shuttle-orbiter reentry at Mach 22 and angle of attack 40.8 deg and the perfect-gas problem of an aerobraking orbital-transfer vehicle with an ellipsoidal/60-deg cone and a toroidal sonic shoulder. The advantages of the improved code in terms of accuracy and computation time are indicated.

T.K.

A85-19698#

A NAVIER-STOKES CALCULATION OF 3-D, TURBULENT FLOW NEAR A PROPELLER IN A SHEAR FLOW

D. H. PELLETIER (Virginia Polytechnic Institute and State University, Blacksburg, VA; Montreal, Universite, Montreal, Canada) and J. A. SCHETZ (Virginia Polytechnic Institute and State University, Blacksburg, VA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 14 p. Navy-supported research. refs
(AIAA PAPER 85-0365)

A numerical procedure based on the primitive variable Navier-Stokes equations is applied to the simulation of the three-dimensional flow near a propeller in a shear flow. The Navier-Stokes equations are solved by a Penalty Finite Element Method. The propeller is modelled as an actuator disk, and the

direct simulation of a given propeller is considered in detail. Turbulent transport is modeled by an integrated Turbulent Kinetic Energy equation. This approach results in a robust numerical algorithm. Detailed comparison with wind tunnel measurements shows good prediction of velocity and pressure. The high accuracy of the swirl prediction is a major improvement over previous analyses. Author

A85-19699*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

RECENT ADVANCES IN COMPUTATIONAL TRANSONIC AERODYNAMICS

J. C. SOUTH, JR. (NASA, Langley Research Center, Hampton, VA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 11 p. refs (AIAA PAPER 85-0366)

The near-term prospects are discussed for calculation of viscous transonic flow fields about realistic configurations at full-scale Reynolds numbers. Three basic algorithms are considered: The central-difference, three-factor ADI method; the central-difference, explicit, multistep Runge-Kutta method with multigrid acceleration; and the relaxation method for the upwind-differenced, flux-split equations. Each method has distinct advantages and disadvantages regarding stability, convergence rate, and vectorizability. It appears that computation times can be 15 to 60 hours on the latest super computers unless 3D algorithms are improved to perform as well as current 2D algorithms. Author

A85-19700*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

BREAKDOWN OF THE CONSERVATIVE POTENTIAL EQUATION

M. D. SALAS and C. R. GUMBERT (NASA, Langley Research Center, Transonic Aerodynamics Div., Hampton, VA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 15 p. refs (AIAA PAPER 85-0367)

The conservative full-potential equation is used to study transonic flow over five airfoil sections. The results of the study indicate that once shock waves are present in the flow, the qualitative approximation is different from that observed with the Euler equations. The difference in behavior of the potential eventually leads to multiple solutions. Author

A85-19701*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

THE NUMERICAL SIMULATION OF STEADY TRANSONIC ROTATIONAL FLOW USING A DUAL POTENTIAL FORMULATION

N. M. CHADERJIAN and J. L. STEGER (NASA, Ames Research Center, Moffett Field, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 12 p. refs (AIAA PAPER 85-0368)

A finite-difference method is presented that simulates steady transonic rotational flow of an inviscid fluid by representing the velocity field as the sum of scalar and vector potentials. This dual potential velocity decomposition extends the validity of the scalar (full) velocity potential to include vorticity. The inclusion of a vector potential also permits an alternate treatment of lift that does not require a circulation wake cut. This is accomplished by specifying the vector potential as a constant on the airfoil surface in order to satisfy a Kutta condition. The governing equations are solved as iteratively decoupled scalar equations using approximate factorization techniques, and the overall efficiency approaches that of the full potential equation. The governing equations are able to convect entropy and vorticity throughout the flow field and are equivalent to the Euler equations in continuous flow domains, however at shocks the Rankine-Hugoniot entropy jump must be supplied. An entropy correction method is presented and verified with transonic airfoil solutions of the Euler equations. Author

A85-19702#

SHOCK WAVES IN TRANSONIC CHANNEL FLOWS AT MODERATE REYNOLDS NUMBER

J. MACE (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) and T. C. ADAMSON, JR. (Michigan, University, Ann Arbor, MI) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 11 p. refs (AIAA PAPER 85-0369)

The behavior of shock waves in transonic channel flow with varying Reynolds and Prandtl numbers is examined using analytical and numerical methods. It is shown that the location of the sonic line within the structure of a shock wave is independent of Reynolds number and is coincident with the location of the corresponding discontinuous wave in the limit as Reynolds number tends to infinity. Also, in a numerical solution, truncation errors and artificial viscosity produce a smeared shock wave which is similar to that found in a flow at moderate Reynolds number. Thus, this research lends support to the commonly accepted supposition that the position of the sonic line within the structure of a numerical shock wave can be adopted as the location of the corresponding shock wave in inviscid flow. Author

A85-19703#

VISCOUS/INVISCID INTERACTION ANALYSIS OF TRANSONIC SHOCK INDUCED SEPARATED FLOW INCLUDING NORMAL PRESSURE GRADIENTS

D. E. EDWARDS, J. E. CARTER (United Technologies Research Center, East Hartford, CT), and M. M. HAFEZ (Computer Dynamics, Inc., Hampton, VA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 12 p. refs (Contract F49620-81-C-0041) (AIAA PAPER 85-0371)

An analysis based on an Interacting Boundary Layer Theory is presented for the prediction of transonic shock-wave, boundary-layer interaction with emphasis on turbulent separated flow. In this analysis finite difference techniques are used to iteratively solve the viscous layer equations, expressed in a defect form, coupled to a stream function representation of the inviscid flow. Normal pressure gradients and imbedded shock effects are included in this analysis. Favorable comparisons which have been obtained with the separated flow data of Kooi demonstrate that for transonic shock induced separation the effect of displacement thickness interaction dominates over that produced by imbedded shock effects and normal pressure gradients. Calculations made with a modified algebraic turbulence model demonstrate that for separated flow cases the computed results are more sensitive to the turbulence model than to whether or not normal pressure gradients are included. Author

A85-19705#

NAVIER-STOKES COMPUTATIONS OF AXISYMMETRIC TRANSONIC FLOWS WITH A TWO-EQUATION MODEL OF TURBULENCE

J. SAHU (U.S. Army, Ballistics Research Laboratory, Aberdeen Proving Ground, MD) and J. E. DANBERG (Delaware, University, Newark, DE) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 13 p. refs (AIAA PAPER 85-0373)

Computational techniques developed for describing the aerodynamics of artillery shell flight are presented. A two-equation turbulence model (TET) is introduced into a thin-layer azimuthally-invariant, time-dependent Navier-Stokes model which features the same implicit algorithm and generalized geometry. The TET, a kappa-epsilon model, is modified to fit a conformal coordinate system by adjusting the expressions for the turbulent kinetic energy and dissipation rate. Solutions are obtained with the Beam-Warming (1977) fully implicit, approximately factored finite difference technique after specifying boundary conditions at the wall. The results of sample calculations for an attached flow over an axisymmetric projectile and separated flow over an axisymmetric

bump model are provided in terms of the surface pressures, velocity, turbulent kinetic energy, dissipation rate, and the Re shear stress profiles. Comparisons with experimental data confirms that the kappa-epsilon model is valid for describing the wake or base flow behind a projectile. M.S.K.

A85-19708#
IS THE FREE FLIGHT/WIND TUNNEL EQUIVALENCE CONCEPT VALID FOR UNSTEADY VISCOUS FLOW?

L. E. ERICSSON (Lockheed Missiles and Space Co., Inc., Sunnyvale, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 8 p. refs
 (AIAA PAPER 85-0378)

The extent to which unsteady flow has been numerically described in dynamic stall conditions around compressor and helicopter blades for which wind tunnel data are available is assessed. The stall behavior of the blades has normally been tested in wind tunnels after calculations have predicted the onset of stall at a specific angle of attack (AOA) and rate of change. It is noted that the nonuniform velocity distribution at a compressor inlet produces a continuously varying AOA at the blades. Separation on the lee side is then delayed when the free stream accelerates and is induced when the free stream decelerates. Separation delay is associated with a lift coefficient overshoot that is proportional to the blade plunging velocity, wherein a vortex is shed at the end of the upstroke and produces lift. Wind tunnel data for unsteady flow, obtained by accelerating the flow over the airfoils, does not provide data on the overshoot and therefore does not represent helicopter blade encounters with gusts. M.S.K.

A85-19730*# Ohio State Univ., Columbus.
DETAILED MEASUREMENTS OF THE FLOWFIELD IN THE VICINITY OF AN AIRFOIL WITH GLAZE ICE

M. B. BRAGG and W. J. COIRIER (Ohio State University, Columbus, OH) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 11 p. NASA-supported research. refs
 (AIAA PAPER 85-0409)

An experimental study has been conducted in the OSU subsonic tunnel to measure the characteristics of the separation bubble on an airfoil with glaze ice. A measured glaze ice accretion on a NACA 0012 airfoil was simulated in wood for this dry tunnel test. The 21 inch chord model was pressure belted and the ice shape internally tapped to obtain surface pressures, lift and moment coefficients. A wake survey probe was used to obtain airfoil drag. The separation bubble was explored by measuring the time averaged velocities using a split film probe. The probe was positioned using a computer controlled two-dimensional traversing system. In this paper, airfoil lift, drag, and moment coefficient data are compared for the airfoil with and without glaze ice. Velocity profiles in the separation bubble are presented for several chordwise stations at three angles of attack. The ice shape caused a severe lift and drag penalty. The velocity profiles show clearly the large bubble geometry, regions of reversed flow, and bubble reattachment. Author

A85-19731*# Akron Univ., Ohio.
PROGRESS IN DEVELOPMENT OF A NAVIER-STOKES SOLVER FOR EVALUATION OF ICED AIRFOIL PERFORMANCE

M. G. POTAPCZUK (Akron, University, Akron, OH) and P. M. GERHART (Evansville, University, Evansville, IN; Akron, University, Akron, OH) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 19 p. refs
 (Contract NAG3-416)
 (AIAA PAPER 85-0410)

A method is being developed for evaluation of the flow field behavior about an airfoil with significant ice accretion on the leading edge. The computer code, being evaluated for this purpose, solves the Navier-Stokes equations in a body-fitted curvilinear coordinate system. This requires the use of a grid generation code to transform the x-y coordinates of the physical space into xi-eta coordinates

of the computational space. Evaluation of the suitability of these two codes for predicting iced airfoil performance is presently being carried out in anticipation of use in an overall icing analysis effort. Results of this evaluation to date indicate good correlation with known information on clean airfoils. Preliminary results for rime and glaze, iced airfoil shapes are also presented. Author

A85-19732#
COMPUTATIONAL PARTICLE TRAJECTORY ANALYSIS ON A 3-DIMENSIONAL ENGINE INLET

J. J. KIM (Boeing Military Airplane Co., Wichita, KS) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 10 p. Research supported by the Boeing Military Airplane Co. refs
 (AIAA PAPER 85-0411)

The paper discusses a computational particle trajectory analysis code applied to the problem of water droplet impingement on a 3-dimensional engine inlet. The droplet equation of motion is solved numerically by a fourth order Adams predictor-corrector scheme. The method utilizes state-of-the-art parametric surface modeling techniques and computational fluid dynamics code to predict local impingement efficiency distribution on a representative 3-dimensional engine inlet configuration. Results are presented for a typical take-off power setting at two angles of attack. Comparison with test results for the classical problem of droplet impingement on a sphere is also presented. Author

A85-19733*# Atmospheric Science Associates, Bedford, Mass.
THREE-DIMENSIONAL AIRFLOW AND HYDROMETEOR TRAJECTORY CALCULATION WITH APPLICATIONS

H. G. NORMENT (Atmospheric Science Associates, Bedford, MA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 10 p. Army-NASA-sponsored research. refs
 (AIAA PAPER 85-0412)

Numerical codes developed to model potential flows about three-dimensional bodies and applied to examining the flowfields around aircraft nose probes for gathering hydrometeor data are described. The potential flow code accounts for lifting or nonlifting surfaces, the effects of lift vorticity, inlet flows, and compression effects. Particle trajectories are calculated using particle equations of motion, with note taken of conditions in both the far- and near-fields of the flow. Graphic projections of the trajectories can be made from any view angle using another code. The codes also contain routines for handling flow velocities around arrays of spatial locations, trajectory arrays, and the effects of flow distortion on the particle flux. M.S.K.

A85-19738#
BODY FLOW FIELD SIMULATION AND FORCE/MOMENT PREDICTION AT TRANSONIC SPEEDS

B. S. ROSEN (Grumman Aerospace Corp., Bethpage, NY) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 8 p. refs
 (AIAA PAPER 85-0423)

Historically, investigators have devoted more attention to transonic wing-type flow simulations than to body-type flows. Full potential methods for 2-D axisymmetric flow have been developed, but have not been extended to treat the 3-D lifting case. Small disturbance methods for the inviscid treatment of bodies at incidence are available, but these impose boundary conditions on a constant cross-section shell which only approximates the true body shape. During a recent study, long-standing problems associated with the small disturbance/shell formulation were resolved when a grid which conforms to the true body shape was introduced. The resulting small disturbance/conformal grid computational method is described. Correlations with experimental data and 2-D full potential calculations are included. Author

A85-19740*# Grumman Aerospace Corp., Bethpage, N.Y.
TRO-2D - A CODE FOR RATIONAL TRANSONIC AERODYNAMIC OPTIMIZATION

W. H. DAVIS, JR. (Grumman Aerospace Corp., Bethpage, NY) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 9 p. refs (Contract NAS1-17292)
 (AIAA PAPER 85-0425)

Features and sample applications of the transonic rational optimization (TRO-2D) code are outlined. TRO-2D includes the airfoil analysis code FLO-36, the CONMIN optimization code and a rational approach to defining aero-function shapes for geometry modification. The program is part of an effort to develop an aerodynamically smart optimizer that will simplify and shorten the design process. The user has a selection of drag minimization and associated minimum lift, moment, and the pressure distribution, a choice among 14 resident aero-function shapes, and options on aerodynamic and geometric constraints. Design variables such as the angle of attack, leading edge radius and camber, shock strength and movement, supersonic pressure plateau control, etc., are discussed. The results of calculations of a reduced leading edge camber transonic airfoil and an airfoil with a natural laminar flow are provided, showing that only four design variables need be specified to obtain satisfactory results. M.S.K.

A85-19742#
COMPUTATIONAL AERODYNAMIC DESIGN OF THE GULFSTREAM IV WING

R. M. CHANDRASEKHARAN, W. R. MURPHY (Gulfstream Aerospace Corp., Savannah, GA), F. P. TAVERNA, and C. W. BOPPE (Grumman Aerospace Corp., Bethpage, NY) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 7 p.
 (AIAA PAPER 85-0427)

A wing has been designed for the Gulfstream IV aircraft with the objective of improving upon the aerodynamic performance of the Gulfstream III. Computational methods capable of simulating the flow about this configuration, complete with nacelles and winglets, were implemented to enhance the probability that the desired effects would be verified by wind tunnel experimentation. Test results from the ARA Transonic Wind Tunnel at Bedford, England, confirmed all pre-test predictions. The aerodynamic improvements will result in a G-IV range increment of over 300 nautical miles. Author

A85-19746#
SHOCK INDUCED VORTICES ON ELLIPTIC CONES IN SUPERSONIC FLOW

F. MARCONI (Grumman Aerospace Research and Development Center, Bethpage, NY) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 11 p. refs
 (Contract F49620-84-C-0056)
 (AIAA PAPER 85-0433)

A numerical study of the conical, supersonic, inviscid flow about elliptic cross section cones is presented. Although the flow is assumed inviscid, the vorticity produced by the shock system can cause the formation of vortices. The Euler equations are solved and all shock waves are fit as discrete discontinuities. This phenomenon has been shown to be a valid solution of the Euler equations. The production of vorticity by shock waves in the flow about wing-type bodies is studied. The vorticity in the flow field that may be shed from a separating boundary layer is not considered in this paper. The computed flow fields are compared with experimental data, full potential calculations and results from other Euler solvers. Author

A85-19747#
SPLIT-FLUX-VECTOR SOLUTIONS OF THE EULER EQUATIONS FOR THREE-DIMENSIONAL CONFIGURATIONS

J. E. DEESE (McDonnell Douglas Research Laboratories, St. Louis, MO) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 11 p. Research supported by the McDonnell Douglas Independent Research and Development Program. refs
 (AIAA PAPER 85-0434)

A numerical solution method for the three-dimensional unsteady Euler equations is developed using flux-vector-splitting concepts. A finite-volume spatial discretization is applied to the equations written in body-conforming curvilinear coordinates. An explicit upwind predictor-corrector method is employed to integrate the spatially discretized equations in time. The resulting algorithm is second order in space and time, uses local time steps to accelerate convergence, and is stable for a Courant number of two. Results for wings in subsonic, transonic, and supersonic flow are compared with experimental data and the predictions of a central-difference, finite-volume Euler code where available. Author

A85-19748#
FINITE VOLUME SOLUTION OF THE TWO-DIMENSIONAL EULER EQUATIONS ON A REGULAR TRIANGULAR MESH

A. JAMESON and D. MAVRIPLIS (Princeton University, Princeton, NJ) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 11 p. refs
 (AIAA PAPER 85-0435)

Rectangular and triangular grids are compared for solution of the Euler equations for two-dimensional transonic flow around an airfoil. A Karman-Trefftz transformation is used to map the airfoil to a near-circle and a family of near-circles is then generated, together with radial lines to form a quadrilateral grid. Drawing diagonals in the resulting grid produces a triangular mesh. The Euler equations are then discretized to obtain the pressure, density, velocity, total energy, and total enthalpy. Extra dissipation terms are added to prevent decoupling between odd and even cells and the boundary and time-stepping schemes are defined. A multigrid treatment with high frequency error damping characteristics is applied to accelerate the convergence. Sample calculations for a NACA 0012 airfoil are provided. The accuracy is found to be comparable to that found with a quadrilateral grid. M.S.K.

A85-19749*# Massachusetts Inst. of Tech., Cambridge.
SOLUTION METHOD FOR A HOVERING HELICOPTER ROTOR USING THE EULER EQUATIONS

T. W. ROBERTS and E. M. MURMAN (MIT, Cambridge, MA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 13 p. refs
 (Contract NGT-22-009-901; NAG2-105; NAG2-275)
 (AIAA PAPER 85-0436)

A method for the calculation of the flow field of a helicopter rotor blade in hover is presented. The approach uses a finite volume solution of the three dimensional Euler equations for the blade near field. In the Euler solver the velocity field is decomposed into two parts. One is the induced velocity of the vortex wake extending below the blade, found from a free wake calculation procedure. The other part is the unknown additional velocity field of the rotor blade. This approach eliminates numerical diffusion of the rolled up wake vorticity due to truncation error and artificial viscosity. Also, the effects of the far wake are included in the limited computational domain. Solutions are presented for an isolated wing and a model helicopter rotor and compared to experiment. Author

02 AERODYNAMICS

A85-19755#

TRAPPING OF FREE VORTEX BY AIRFOILS WITH SURFACE SUCTION

C.-Y. CHOW (Colorado, University, Boulder, CO), M.-K. HUANG (Nanjing Aeronautical Institute, Nanjing, People's Republic of China; Colorado, University, Boulder, CO), and C.-L. CHEN American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 8 p.

(Contract AF-AFOSR-84-0037)

(AIAA PAPER 85-0446)

The free vortex on whose capture the augmentation of an airfoil's lift depends is unstable at most of its equilibrium positions, except at those in a narrow region above the trailing edge. It is presently reported that additional, stable positions may be established through the application of suction through the upper surface of the airfoil. In such cases, the strong vortex trapped above the airfoil is noted to be capable of generating much greater lift than the airfoil without suction modification. O.C.

A85-19756#

VISUALIZATION OF THE SPANWISE VORTEX STRUCTURE IN THE STARTING FLOW BEHIND AN AIRFOIL

P. FREYMUTH, W. BANK, and F. FINAISH (Colorado, University, Boulder, CO) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 10 p. refs

(Contract AF-AFOSR-81-0027)

(AIAA PAPER 85-0447)

The smoke technique is presently used at moderate Reynolds number and at angles of attack beyond the static stall angle, in order to visualize spanwise vortical structure and development as they occur in accelerated flow around an airfoil starting from rest. Although leading and trailing edge vortical development starts out two-dimensionally, it passes through a complex series of three-dimensional stages until it reaches the turbulent state. O.C.

A85-19759#

EVALUATION OF VORTEX WAKE PREDICTIONS IN THE SWINT CODE

M. I. ADIASOR and R. J. KRIEGER (McDonnell Douglas Astronautics Co., St. Louis, MO) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 8 p. refs

(AIAA PAPER 85-0450)

Semi-empirical approaches are often used to model boundary layer separation effects in inviscid flowfield solutions based upon Euler's equations. In this paper, these approaches are described and the SWINT Euler code is used to investigate the sensitivity of flowfield predictions to the separation model. To assess the effects of the boundary layer separation model both a line integral and area integral for the circulation introduced into the flowfield were developed. Sensitivities of mass, moment and energy flux, circulation, pitching moment, normal force and pressure predictions to the boundary layer separation model are identified. A separation model based upon a control volume at separation is developed which allows the flow variables to satisfy the continuity, momentum and energy equations at separation and controls and amount of circulation introduced at separation. This model is recommended for inclusion in Euler codes when coupled to boundary layer solutions. Author

A85-19760#

CROSSFLOW DRAG OF FINITE-LENGTH RECTANGULAR WING-BODIES

E. S. LARSON (Flygtekniska Forsoksanstalten, Bromma, Sweden) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 9 p. Research supported by the Forsvaret Materielverk. refs

(AIAA PAPER 85-0451)

The crossflow drag coefficient for finite-length cylinders with strakes in the form of slender rectangular wings has been constructed empirically from experimental results on the crossflow

drag coefficient for cylinders with strakes in two-dimensional, subsonic-transonic flow by applying to the result crossflow drag proportionality factors empirically obtained also. The result is restricted to Mach numbers less than or equal to one. Experiments with straked finite-length cylinders are needed for a final quantification of a crossflow drag proportionality factor of interference type, at present estimated by a conjecture. Author

A85-19761*#

McDonnell-Douglas Astronautics Co., St. Louis, Mo.

CORRELATION AND ANALYSIS OF OIL FLOW DATA FOR AN AIR-BREATHING MISSILE MODEL

S. L. STOY (McDonnell Douglas Astronautics Co., St. Louis, MO), J. L. DILLON (NASA, Langley Research Center, Hampton, VA), and A. P. ROMAN American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 8 p. refs

(AIAA PAPER 85-0452)

This paper will present the results of an oil flow investigation on an airbreathing missile model. This oil flow study examined the flow around the model, which can be configured with both axisymmetric and two-dimensional inlets. Flow visualization analyses were conducted for both types of geometries by examining the surface flow patterns made visible by the oil flows for Mach numbers of 2.5 and 3.95. The analysis has shown the extent of flow spillage around the inlet which has helped explain the force and moment data collected during previous testing of the model. The oil flow data has also been used to develop guidelines for modeling the location of the crossflow separation line along inlet fairings. Finally, the oil flow analysis has been used to identify unique features of the boattail flow. These boattail flow characteristics have been correlated with previous oil flow analysis of noncircular body models. This paper demonstrates the use of this type of oil flow analysis in developing missile flow field analysis and aerodynamic predictions ranging from impact angle methods through Navier-Stokes methods. Author

A85-19762*# Martin Marietta Aerospace, Orlando, Fla.

EXPERIMENTAL STUDY OF FORWARD-LOCATED JET-INTERACTION NOZZLES

R. J. CAVALLERI, R. E. WITTMAYER, A. J. CIAPONI (Martin Marietta Aerospace, Orlando, FL), and J. W. KEYES (NASA, Langley Research Center, Hampton, VA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 9 p.

(AIAA PAPER 85-0454)

The effects of forward-mounted sonic jet-interaction nozzles with one, three equal, or one large and two small orifices on the transitional or turbulent boundary-layer flow over a biconic (9-deg-25-arcmin/6-deg) model at angle of attack -10 to the 15 deg and Reynolds number 8.10×10^6 to the 6th/ft are investigated experimentally using pressure taps, force measurements, oil-flow visualization, and schlieren photography in the 20-in. Mach-6 wind tunnel at NASA Langley. The injection flow rates are 0.055 and 0.026 lbm/s, with stagnation pressure 500 psia, stagnation temperature 1000 R, and dynamic pressure 8.7 psia. The results are presented in diagrams, graphs, and photographs and characterized. Moment amplification factors of 1.0 or better (maximum 1.8 at angle of attack 15 deg and flow rate 0.055 lbm/s) are observed for all nozzle types, but the configuration with three unequal orifices is found to give improvements of 10 percent over the single-orifice nozzle at a given flow rate. T.K.

A85-19776#

TOMOGRAPHIC RECONSTRUCTION OF THREE-DIMENSIONAL FLOW OVER AIRFOILS

D. MODARRESS, H. TAN, J. D. TROLINGER (Spectron Development Laboratories, Inc., Aeromechanics Laboratory, Costa Mesa, CA), and Y. YU (U.S. Army, Army Aviation Research and Development Command, Moffett Field, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 9 p. refs
(Contract DAAG29-83-C-0012)
(AIAA PAPER 85-0479)

New developments have led to the feasibility to conduct a quantitative analysis of three-dimensional density fields with the aid of tomographic methods. An important aerodynamic problem which requires use of this technology involves the three-dimensional flow field which occurs at the tip of a rotating airfoil depicting a helicopter rotor blade. This three-dimensional flow field is reconstructed using holographic interferometry. There are, however, a number of difficulties associated with the reconstruction of phase objects. Details regarding the tomographic reconstruction of flow over air foils are discussed, taking into account the experimental setup at the anechoic hover chamber, the digitization program, the iterative refinement of a least-squares solution of linear equations, numerical experimentation, and the reconstruction of experimental data. G.R.

A85-19777#

A COMPARATIVE STUDY BETWEEN AN IMPLICIT AND EXPLICIT ALGORITHM FOR TRANSONIC AIRFOILS

M. R. VISBAL and J. S. SHANG (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 13 p. refs
(AIAA PAPER 85-0480)

A critical examination of several aspects of the numerical simulation of high Reynolds number transonic airfoil flows is presented. Subcritical and supercritical flow fields about an aft-cambered airfoil were generated by solving the mass-averaged Navier-Stokes equations with turbulence incorporated through an algebraic eddy viscosity model. The governing equations were solved on curvilinear body-fitted grids utilizing two different algorithms, i.e., MacCormack's explicit and Beam-Warming implicit. The numerical uncertainties associated with different schemes, grid resolution, artificial viscosity and far field boundary placement were investigated, and found to be of the same order of magnitude or less than the corresponding uncertainties in the available experimental data. Comparison of computed and experimental results showed good prediction of all the essential flow features. However, detailed comparison of velocity profiles pointed out deficiencies of the turbulence model downstream of the shock/boundary layer interaction in the airfoil cove and in the near-wake. Thin-layer and Navier-Stokes computed results were found in excellent agreement with each other. However, the Euler equations failed to provide a reasonable approximation of the flow due to the dramatic viscous-inviscid interaction effects for supercritical airfoils. Author

A85-19778#

A NEW SINGULAR INTEGRAL METHOD FOR COMPRESSIBLE POTENTIAL FLOW

D. E. WILSON (Texas, University, Austin, TX) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 7 p.
(AIAA PAPER 85-0481)

The present investigation is concerned with a new singular integral technique for solving the full nonlinear potential flow equations describing the outer flow field about an arbitrary body. The only approximations employed are related to the usual potential flow boundary layer restrictions. The mathematical formulation is discussed, taking into account a symmetrical airfoil at some angle of attack with respect to a uniform free stream. A successive approximation technique is employed. The method involves the generation of a series of linear differential equations. The solution

of the two-dimensional potential flow equations is reduced to a one-dimensional problem. G.R.

A85-19779*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

EFFICIENT SELF-CONSISTENT VISCOUS-INVISCID SOLUTIONS FOR UNSTEADY TRANSONIC FLOW

J. T. HOWLETT (NASA, Langley Research Center, Hampton, VA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 11 p. refs
(AIAA PAPER 85-0482)

An improved method is presented for coupling a boundary layer code with an unsteady inviscid transonic computer code in a quasi-steady fashion. At each fixed time step, the boundary layer and inviscid equations are successively solved until the process converges. An explicit coupling of the equations is described which greatly accelerates the convergence process. Computer times for converged viscous-inviscid solutions are about 1.8 times the comparable inviscid values. Comparison of the results obtained with experimental data on three airfoils are presented. These comparisons demonstrate that the explicitly coupled viscous-inviscid solutions can provide efficient predictions of pressure distributions and lift for unsteady two-dimensional transonic flows. Author

A85-19781#

GRID ADAPTATION FOR THE 2-D EULER EQUATIONS

J. F. DANNENHOFFER, III and J. R. BARON (MIT, Cambridge, MA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 12 p. refs
(Contract AF-AFOSR-82-0136)
(AIAA PAPER 85-0484)

An adapted grid technique for accurate and efficient solutions of the steady, two-dimensional Euler equations is presented. Embedded meshes, which are coupled to a fixed global mesh via a multiple-grid technique, are employed. The effect of choosing various adaptation strategies is examined. Solutions are presented for isolated lifting airfoils in subcritical as well as transonic flow. The supersonic flow over a circular-arc cascade with a complex shock structure is also presented. In all cases, the adapted solution achieved the same accuracy as global refinement, but required a factor of between 5 and 7 less computer time and between 3 and 8 less storage. Author

A85-19783*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

A THREE-DIMENSIONAL ADAPTIVE GRID METHOD

K. NAKAHASHI and G. S. DEIWERT (NASA, Ames Research Center, Moffett Field, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 12 p. refs
(AIAA PAPER 85-0486)

A three-dimensional solution-adaptive-grid scheme is described which is suitable for complex fluid flows. This method, using tension and torsion spring analogies, was previously developed and successfully applied for two-dimensional flows. In the present work, a collection of three-dimensional flow fields are used to demonstrate the feasibility and versatility of this concept to include an added dimension. Flow fields considered include: (1) supersonic flow past an aerodynamic afterbody with a propulsive jet at incidence to the free stream, (2) supersonic flow past a blunt fin mounted on a solid wall, and (3) supersonic flow over a bump. In addition to generating three-dimensional solution-adapted grids, the method can also be used effectively as an initial grid generator. The utility of the method lies in: (1) optimum distribution of discrete grid points, (2) improvement of accuracy, (3) improved computational efficiency, (4) minimization of data base sizes, and (5) simplified three-dimensional grid generation. Author

A85-19784*# North Carolina State Univ., Raleigh.

APPLICATION OF A VARIATIONAL METHOD FOR GENERATING ADAPTIVE GRIDS

R. I. KREIS, H. A. HASSAN (North Carolina State University, Raleigh, NC), and F. C. THAMES (NASA, Langley Research Center, Hampton, VA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 10 p. refs

(AIAA PAPER 85-0487)

The application of variational methods for generating adaptive grids is not as straightforward as one is led to believe. Proper scaling, suitable weight functions and appropriate clustering on boundaries must be employed to obtain a satisfactory grid. This work, which is based on the framework developed by Brackbill and Saltzman, provides simple methods for determining scaling and investigates possible options for selecting the weight function and clustering points on the boundaries. The concepts developed here are applied to two two-dimensional problems: a model problem based on Burger's equation which contains two length scales and, transonic flow past airfoils using the Euler equations. Author

A85-19785*#

AN IMPLICIT, CONSERVATIVE, ZONAL-BOUNDARY SCHEME FOR EULER EQUATION CALCULATIONS

M. M. RAI (NASA, Ames Research Center, Moffett Field; Informatics General Corp., Palo Alto, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 23 p. refs

(AIAA PAPER 85-0488)

A 'zonal', or 'patched-grid', approach is one in which the flow region of interest is divided into subregions which are then discretized independently, using existing grid generators. The equations of motion are integrated in each subregion in conjunction with zonal-boundary schemes which allow proper information transfer across interfaces that separate subregions. The zonal approach greatly simplifies the treatment of complex geometries and also the addition of grid points to selected regions of the flow. In this study a conservative, zonal-boundary condition that could be used with explicit schemes has been extended so that it can be used with existing second-order-accurate implicit integration schemes such as the Beam-Warming and Osher schemes. In the test case considered, the implicit schemes increased the rate of convergence considerably (by a factor of about 30 over that of the explicit scheme). Results demonstrating the time-accuracy of the zonal scheme and the feasibility of performing calculations on zones that move relative to each other are also presented.

Author

A85-19787#

LAMINAR BOUNDARY LAYER STABILITY EXPERIMENTS ON A CONE AT MACH 8. III - SHARP CONE AT ANGLE OF ATTACK

K. F. STETSON (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH), E. R. THOMPSON (Arnold Engineering Development Center, Arnold AF Station, TN), J. C. DONALDSON, and L. G. SILER (ARVIN/CALSPAN Field Services, Inc., Arnold AF Station, TN) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 25 p. refs

(AIAA PAPER 85-0492)

The stability of the laminar boundary layer on a sharp, 7-degree half angle cone at free-stream $M = 8$ was experimentally investigated using hot-wire anemometry techniques. Angle of attack effects were obtained from measurements on the windward meridian at two and four degrees angle of attack and on the leeward meridian at two degrees angle of attack. Small angles of attack were found to make significant changes, compared to zero angle of attack, in the stability characteristics of the boundary layer. The experimentally detectable critical Reynolds number increased on the windward meridian and appeared to decrease on the leeward meridian. The amplification rates of second mode disturbances were not greatly affected by angle of attack; whereas, first mode disturbance growth was reduced on the windward

meridian. Higher frequency disturbance growth was delayed to higher local Reynolds numbers on the windward meridian and occurred at lower local Reynolds numbers on the leeward meridian. Windward meridian transition Reynolds numbers were larger than expected.

Author

A85-19788*# Stanford Univ., Calif.

DISTURBANCE-WAVE INTERACTIONS IN FLOWS WITH CROSSFLOW

H. L. REED (Stanford University, Stanford, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 13 p. refs

(Contract NAG1-402)

(AIAA PAPER 85-0494)

The leading-edge region of swept wings is dominated by the crossflow instability, resulting in vortices that all rotate in the same sense. The effect of these possibly unsteady vortices on the behavior of other disturbances is examined, and a strong interaction between these and disturbances of half the dominating crossflow wavelength is predicted. According to theory, the interaction is of crossflow-crossflow type. The effect explains the anomalies found in the experimental observations of Saric and Yeates. Visually, they observe vortices at the wavelength predicted by linear theory; however, in their hot-wire measurements they find that the superharmonic dominates disturbance growth, eventually having three times the amplitude of the primary wave. In this case, the usual transition prediction methods would fail, clearly indicating the importance of studying interactions of this sort.

Author

A85-19798#

SIMULATION OF TRANSONIC THREE-DIMENSIONAL NACELLE/INLET FLOWFIELDS USING AN EULER/NAVIER-STOKES ALGORITHM

J. VADYAK (Lockheed-Georgia Co., Marietta, GA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 14 p. Research sponsored by the Lockheed Independent Research and Development Program. refs

(AIAA PAPER 85-0084)

An analysis is presented for calculating steady (or unsteady) three-dimensional aircraft inlet flowfields. This algorithm can compute the flowfield about axisymmetric or arbitrary asymmetric nacelle/inlet configurations with or without centerbodies at zero or nonzero incidence at subsonic, transonic, or supersonic free-stream speeds. The algorithm can solve either the Euler momentum equations for inviscid flow, the thin-shear-layer Navier-Stokes equations for viscous flow, or the full Navier-Stokes equations for viscous flow. The flowfield is determined on a body-fitted numerically-generated computational grid. A fully-implicit alternating-direction-implicit algorithm is employed for solution of the finite-difference equations. Numerical results and correlations with existing methods and experiment are presented to illustrate application of the analysis for cases at subsonic and transonic free-stream speeds.

Author

A85-19821

VORTEX PATH IN THE SUPERSONIC WAKE OF A ROUGH EVEN PLATE [WIRBELSTRASSE IM UBERSCHALLNACHLAUF EINER RAUHEN EBENEN PLATTE]

M.-Z. TANG Aachen, Rheinisch-Westfaelische Technische Hochschule, Fakultät fuer Maschinenwesen, Dr.-Ing. Dissertation, 1983, 96 p. In German. refs

The supersonic vortex path of a plate is described, and the influence of the boundary conditions of plate thickness, relative roughness, and plate trailing edge shape on the vortex path formation in the supersonic wake is investigated. The results are compared with ones obtained elsewhere for circular cylinders and profiles, and the relationship of the present results to those of Hermann (1972) on the interaction between a compression shock and a supersonic vortex path is addressed. Optical methods are used to determine fluctuations in velocity and density and the frequency of vortex shedding as well as their variations due to

compression shock and the deformation of the shock caused by the vortex path wake. C.D.

A85-19844
COMPUTATION OF TRANSONIC INLET FLOWS [BERECHNUNG SCHALLNAHER EINLAUFSTROEMUNGEN]

U. GIESE Aachen, Rheinisch-Westfaelische Technische Hochschule, Fakultae fuer Maschinenwesen, Dr.-Ing. Dissertation, 1983, 107 p. In German. refs

The compressible flow in a plane inlet is investigated analytically, applying a finite-difference scheme (in nonorthogonal curvilinear coordinates adapted to the wall geometry) to solve the full potential equations for the inviscid flow far from the wall and a factorization procedure to solve the discrete problem. The influence of the boundary conditions on the convergence of the solution is demonstrated; a linear relaxation technique is used in the integration of the differential equations for the stream function; the effect of the wall curvature radius on the solution of the boundary-layer problem is evaluated; and the core and wall flows are coupled via the displacement thickness. Numerical results for subsonic flow and supersonic regions are presented in graphs and compared with published experimental data. T.K.

A85-19848
CIRCULATION AROUND THICK WINGS WITH FREE VORTICES [UMSTROEMUNG VON DICKEN FLUEGELN MIT FREIEN WIRBELN]

P. ZHU Stuttgart, Universitaet, Fakultae Verfahrenstechnik, Dr.-Ing. Dissertation, 1983, 129 p. In German. refs

The panel method is used to calculate the flow around three-dimensional thick wings with tip vortices. The wing tips from which vortices are shed are assumed to be sharp, i.e., the tips are the flow separation lines. Flat rectangular panels and panels composed of a parallelogram and four triangles are used for the wings. Each panel is covered with a dipole distribution of the second order, and the coefficients of the dipole distribution are determined using the least squares method. The position of the vortex layer and the dipole distribution are calculated simultaneously. The results are useful for research on vortex layers and for the aerodynamic design of aircraft. C.D.

A85-19851
A PROCEDURE FOR THE OPTIMIZATION OF THE AEROTHERMODYNAMIC DESIGN OF MULTISTAGE AXIAL COMPRESSORS [VERFAHREN ZUR OPTIMIERUNG DER AEROTHERMODYNAMISCHEN AUSLEGUNG MEHRSTUFIGER AXIALVERDICHTER]

A. BIAGOSCH Muenchen, Technische Universitaet, Fakultae fuer Maschinenwesen, Dr.-Ing. Dissertation, 1984, 156 p. In German. refs

A reduction of fuel consumption is a very significant factor in decreasing costs of aircraft operation, because approximately 50 percent of the direct operating costs of an airliner are related to fuel costs. A reduction in engine fuel consumption can be obtained by achieving savings in the fuel consumption due to specific engine components. The present investigation is concerned with efficiency improvements in the case of axial compressors on the basis of an optimization of the aerothermodynamic design. For a number of reasons, a global solution is not possible, and partial solutions have to be considered. Attention is given to the optimal aerothermodynamic design for an operating point. The optimal partial solution takes into consideration as much as possible requirements related to other partial problems. A computational procedure is developed for optimizing the aerothermodynamic design parameters of multistage axial-flow compressors with the aid of numerical optimization strategies. G.R.

A85-19854

A SUBDOMAIN FINITE ELEMENT METHOD FOR SOLVING THE CONSERVATIVE FULL POTENTIAL EQUATION FOR TRANSONIC PROFILE FLOWS [EIN SUBDOMAIN-FINITE-ELEMENT-VERFAHREN AUR LOESUNG DER KONSERVATIVEN VOLLEN POTENTIALGLEICHUNG FUER TRANSSONISCHE PROFILSTROEMUNGEN]

C. W. LUCCHI Muenchen, Technische Universitaet, Fakultae fuer Maschinenwesen, Dr.-Ing. Dissertation, 1984, 162 p. In German. refs

A subdomain finite element method for solving the conservative full potential equation for wing profiles in the transonic domain is developed along with a procedure for minimizing errors which occur in potential theory when bedded shocks are described. Pressure distributions on shocked objects are corrected using the Rankine-Hugoniot law at the shock and a simple formula behind the shock. The Kutta-Joukowski downflow condition is transformed to take care of the flattening due to static pressure loss. The corrected pressure distribution fulfills the physical requirement that no jump in the corrected static pressure may occur at the trailing edge. The correction extensively ameliorates errors that commonly occur using the potential equation. These results are tested on two profiles and compared with results from conservatively and nonconservatively formulated potential methods and from conservative Euler procedures, with excellent results. C.D.

A85-20025

A NUMERICAL STUDY OF THREE-DIMENSIONAL RADIATION FIELDS IN PROBLEMS OF SUPERSONIC FLOW PAST SEGMENTAL BODIES [CHISLENNOE ISSLEDOVANIJE TREKHMERNOGO RADIATIONNOGO POLIA V ZADACHAKH GIPERZVUKOVOGO OTEKANIIA SEGMENTAL'NYKH TEL]

A. A. KOSTUZIK and A. N. RUMYNSKII (Moskovskii Fiziko-Tekhnicheskii Institut, Moscow, USSR) *Inzhenerno-Fizicheskii Zhurnal* (ISSN 0021-0285), vol. 47, Dec. 1984, p. 941-945. In Russian. refs

A solution is presented to the problem of calculating a three-dimensional radiation field in a shock layer in three-dimensional hypersonic flow of an inviscid, non-heat-conducting, selectively radiating and absorbing gas past segmental bodies. The radiant energy transport is calculated with allowance for the curvature of the shock layer surface and the interaction between the radiation field and the flow field. The shape of the shock wave and distribution of the thermodynamic parameters of the gas in the shock layer are calculated using the Magomedov-Kholodov (1969) method. Numerical calculations of the effect of the multidimensionality of the radiation field on the radiative heat transfer are presented. V.L.

A85-20074

SURVEY ON JET INSTABILITY THEORY

A. MICHALKE (Berlin, Technische Universitaet, Berlin, West Germany) *Progress in Aerospace Sciences* (ISSN 0376-0421), vol. 21, no. 3, 1984, p. 159-199. refs

Theoretical results concerning the instability of axisymmetric jets are reviewed. For inviscid parallel jet flow the various parameters affecting jet instability such as shear layer thickness, Mach number, temperature ratio, and external flow velocity are discussed. Furthermore, viscous and nonlinear effects are considered. Finally, the influences of flow divergence and of nozzle-jet interaction are discussed. Author

A85-20228#

MATRIX SOLUTION OF COMPRESSIBLE FLOW ON S(1) SURFACE THROUGH A TURBOMACHINE BLADE ROW WITH SPLITTER VANES OR TANDEM BLADES

B. WANG and C.-H. WU (Chinese Academy of Sciences, Institute of Engineering Thermophysics, Beijing, People's Republic of China) *Journal of Engineering Thermophysics*, vol. 5, Feb. 1984, p. 18-26. In Chinese, with abstract in English. refs

The basic aerothermodynamic equations of turbomachine flow expressed with respect to nonorthogonal curvilinear coordinates and corresponding nonorthogonal velocity components are used

to solve the compressible flow on $S(1)$ surface in a turbomachine blade row with splitter vanes or tandem blades. The equation of stream function is solved by direct matrix method and the mass flow ratio and outlet flow angle are determined by applying the generalized Joukowski condition to the trailing edges of the main blade and the splitter vane. Typical examples are given to illustrate the effectiveness of the present method. Author

A85-20229#

A NEW APPROACH TO SOME HYBRID AERODYNAMIC PROBLEMS OF AIRFOIL CASCADES ON A GENERAL STREAMSHEET OF REVOLUTION. I

G. LIU (Shanghai Institute of Mechanical Engineering, Shanghai, People's Republic of China) Journal of Engineering Thermophysics, vol. 5, Feb. 1984, p. 27-32. In Chinese, with abstract in English. refs

A novel universal method for solving the inverse problem and hybrid problem of types A, C, and D is proposed, and a new image plane ξ - η is introduced. The solution procedure for the type C hybrid problem, designing a cascade with prescribed profile thickness and suction surface velocity distribution, is illustrated in detail. In comparison with previous approaches, this one is capable of treating blunt nose profiles with higher accuracy and is very suitable for joint use with the optimization theory of cascades. Perhaps the most attractive feature of this approach is its extendability to the solution of the hybrid problem of fully 3-D flow. C.D.

A85-20230#

COMPLETE THREE-DIMENSIONAL FLOW SOLUTION OF A CASCADE INCORPORATING SPLITTER VANES OF ARBITRARY GEOMETRY

D. LIU (Chinese Academy of Sciences, Institute of Engineering Thermophysics, Beijing, People's Republic of China) Journal of Engineering Thermophysics, vol. 5, Feb. 1984, p. 33-39. In Chinese, with abstract in English. refs

An approach to calculate the complete 3-D flow in a cascade incorporating splitter vanes is presented here. The splitter vanes have arbitrary shape to differ from the main vanes. In connection with some references published, this kind of cascade is discussed. The specification of the boundary conditions, the constitution of different solution regions, the accuracy of complete 3-D solution, and the determination of the flow split have been discussed. A model to calculate the flow split ratio is suggested. Author

A85-20231#

CALCULATION AND ANALYSIS OF THE THREE-DIMENSIONAL FLOW IN CENTRIFUGAL COMPRESSOR IMPELLERS

J. CHEN (Chinese Academy of Sciences, Institute of Engineering Thermophysics, Beijing, People's Republic of China) Journal of Engineering Thermophysics, vol. 5, Feb. 1984, p. 40-46. In Chinese, with abstract in English. refs

An improved method for solving the 3-D flow in centrifugal impellers is presented. The method consists of an iterative calculation in two loops. The inner loop is an iterative solution of the aerothermodynamic equations along two sets of nonorthogonal stream surface coordinates. The outer loop is an iterative solution between two correlating flow fields. The 3-D solution is finally reached for the entire space region of the blade passage and its upstream and downstream extensions. The method can be applied to ordinary impellers and impellers with splitters or tandem blades. A comparison is made with measured data for 3-D flow fields. C.D.

A85-20233#

THE FUNDAMENTAL EQUATIONS OF 3-DIMENSIONAL TWO-PHASE PARTICULATE GAS FLOW AND A TWOFOLD STREAM SURFACES MODEL OF SOLUTION FOR PARTICULATE GAS FLOW IN TURBOMACHINES

Z. LING (Chinese Academy of Sciences, Institute of Engineering Thermophysics, Beijing, People's Republic of China) Journal of Engineering Thermophysics, vol. 5, Feb. 1984, p. 51-54. In Chinese, with abstract in English.

A85-20238#

ON THE VARIETY OF TYPE DISCRIMINATION CRITERIA OF EQUATIONS ON S_1 AND S_2 STREAM SURFACES IN TURBOMACHINE

H. CHEN (Chinese Academy of Sciences, Institute of Engineering Thermophysics, Beijing, People's Republic of China) Journal of Engineering Thermophysics, vol. 5, May 1984, p. 135-141. In Chinese, with abstract in English. refs

This paper aims at solving the points at issue on the type discrimination of the partial differential equations of Wu (1952). Some confused understanding is clarified. The type discriminations for the stream-surface problems are correctly made. The relation between the types of the stream-function principal equations and of the systems of equations is found. The type-discrimination criteria of two-dimensional aerodynamic problems are characterized, and some knotty problems in regard to the physical meaning of the type criterion of the inverse problem of the stream surface are explained. Author

A85-20239#

A FAST ALGORITHM FOR SOLVING THE CONSERVATIVE TRANSONIC S_1 FULL POTENTIAL EQUATION EMPLOYING NON-ORTHOGONAL CURVILINEAR COORDINATES AND NON-ORTHOGONAL VELOCITY COMPONENTS

J. ZHANG and C. WU (Chinese Academy of Sciences, Institute of Engineering Thermophysics, Beijing, People's Republic of China) Journal of Engineering Thermophysics, vol. 5, May 1984, p. 142-147. In Chinese, with abstract in English. refs

A fast implicit AC-AF algorithm has been developed to solve the conservative, transonic, S_1 full-potential equation. In the algorithm, the artificial density is introduced to the S_1 full-potential equation, and the solution on S_1 stream surface transonic flow field is obtained by solving the discretized algebraic equations according to the implicit approximate factorization scheme. Results obtained for several turbomachine cascades demonstrate both fast convergence speed and good coincidence agreement of calculated result with the experimental value or available analytic solution. Author

A85-20240#

A STREAM FUNCTION RELAXATION METHOD FOR SOLVING TRANSONIC S_1 STREAM SURFACE WITH RESPECT TO NON-ORTHOGONAL CURVILINEAR COORDINATES

M. GE (Chinese Academy of Sciences, Institute of Engineering Thermophysics, Beijing, People's Republic of China) Journal of Engineering Thermophysics, vol. 5, May 1984, p. 148-153. In Chinese, with abstract in English. refs

The derived stream-function equation in nonorthogonal curvilinear coordinates can be used for solving problems on S_1 or S_2 stream surfaces (including plane, arbitrary-revolution, and twist surfaces). Stream-line coordinates and corresponding orthogonal coordinates are used, and the mixed-difference method is adopted in the numerical calculation for solving transonic S_1 or S_2 stream surface. Through the study of the method of solution for the density field in terms of stream function, a procedure for the predetermination of the density is presented. The calculated examples show satisfactory results. Author

A85-20241#

EFFECT OF INLET AND OUTLET FLOW CONDITIONS ON THE FLOW AND PERFORMANCE OF SUBSONIC TWO-DIMENSIONAL DIFFUSER

L. FANG and X. CHEN (Nanjing Aeronautical Institute, Nanjing, People's Republic of China) Journal of Engineering Thermophysics, vol. 5, May 1984, p. 154-156. In Chinese, with abstract in English.

The effect of a change in inlet and outlet flow conditions on the flow in a two-dimensional diffuser has been studied experimentally in a small-aspect-ratio diffuser tunnel. The experimental result shows that the steady performance and separation point of the flow in the diffuser are substantially affected by the velocity distribution profiles in both directions at the inlet.

The change in the exit geometry of the tested diffuser has only a small effect on the strength of separation region. Author

A85-20554

HYPersonic MULTICYCLE GAS JET WITH A STRONGLY UNDEREXPANDED STREAM AT THE NOZZLE SECTION [O GIPERZVUKOVOI MNOGOTSIKLOVOI STRUE GAZA S SIL'NYM NEDORASSHIRENIEM POTOKA NA SREZE SOPLA]

A. V. IVANOV, N. V. STANKUS, and S. F. CHEKMAREV Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281), Nov.-Dec. 1984, p. 27-35. In Russian. refs

The method of unsteady analogy (i.e., the law of plane sections) is used to perform a theoretical analysis of a hypersonic multicycle jet with a strongly underexpanded stream at the nozzle section. An approximate flow model is developed, and an analytical solution is obtained for the location of the boundary of the multicycle jet. Also obtained is a numerical solution to the corresponding equivalent unsteady problem of the dispersion of a cylindrical gas cluster. It is shown that an experimentally observed decrease in cycle amplitude in the downstream direction is due to energy dissipation in shocks. Here, the cycle length is practically independent of dissipation and is almost constant. Also considered are the effects of heating or cooling, and the problem of a jet in a slightly inhomogeneous atmosphere. L.M.

A85-20557

CONICAL BODIES WITH A STAR-SHAPED TRANSVERSE CROSS SECTION, HAVING A RESERVE OF STATIC STABILITY [KONICHESKIE TELA SO ZVEZDOOBRAZNYM POPERECHNYM SECHENIEM, OBLADAIUSHCHIE ZAPASOM STATICHESKOI USTOICHIVOSTI]

N. A. OSTAPENKO (Moskovskii Gosudarstvennyi Universitet, Moscow, USSR) Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281), Nov.-Dec. 1984, p. 84-92. In Russian.

The paper formulates and solves a variational problem concerning a conical body with a star-shaped transverse cross section, having a maximum reserve of static stability. The similarity law is formulated, and analyses are made of the reserves of static stability for a body with a skewed trailing edge and for a specified midsection area. L.M.

A85-20561

HYPersonic CHEMICALLY NONEQUILIBRIUM VISCOUS SHOCK LAYER ON WINGS WITH A CATALYTIC SURFACE [GIPERZVUKOVOI KHIMICHESKI NERAVNOVESNYI VIAZKII UDARNYI SLOI NA KRYL'IAKH S KATALITICHESKOI POVERKHNOST'IU]

E. A. GERSHBEIN, V. S. SHCHELIN, and S. A. IUNITSKII (Moskovskii Gosudarstvennyi Universitet, Moscow, USSR) Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281), Nov.-Dec. 1984, p. 127-135. In Russian. refs

The theory of a hypersonic viscous shock layer is used to analyze flow past wings of infinite span with a blunt leading edge for different attack and slip angles. Conditions are imposed on the body which allow for first-order heterogeneous catalytic reactions. The flow conditions correspond to the motion of a body having lift force along an entry trajectory into the earth's atmosphere. Attention is given to the flight-altitude dependence of the surface equilibrium temperature along the critical line of the wing as well as to the temperature distribution along the surface of wings with parabolic and hyperbolic contours. It is shown that, for flow regimes with a relatively high degree of dissociation, the dependences of heat flux and surface temperature on the slip angle are nonmonotonic in cases when the fraction of atoms recombined on the surface is small. L.M.

A85-20562

EFFECT OF THE ARRANGEMENT OF APERTURES ON THE GAIN COEFFICIENT DURING ASYMMETRIC GAS INJECTION INTO A LAVAL NOZZLE [VLIANIE RASPOLOZHENIIA OTVERSTII NA KOEFFITSIENT USILENIIA PRI NESIMMETRICHNOM VDUE GAZA V SOPLO LAVALIA]

V. V. ZELENTSOV, V. P. KREMNEV, A. A. NESTEROV, V. V. PORODENKO, and A. A. SHISHKOV Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281), Nov.-Dec. 1984, p. 136-141. In Russian. refs

An experimental determination is made of the gain coefficient in the case of the injection of a transverse gas jet into the supersonic part of an axisymmetric nozzle for different arrangements of apertures along the nozzle and in the injection node for regimes characterized by perturbation propagation to the side of the nozzle opposite to the injection. It is shown that the working range of the injected-gas flowrate in which a sufficiently high efficiency of lateral-force generation is assured can be extended (as compared with injection through a single aperture) by the use of a system of subinjection apertures along with the main aperture. This situation is especially significant when the injection aperture is located deep within the nozzle and the required level of lateral force is sufficiently high. L.M.

A85-20744* United Technologies Corp., East Hartford, Conn.

A LINEARIZED UNSTEADY AERODYNAMIC ANALYSIS FOR TRANSONIC CASCADES

J. M. VERDON and J. R. CASPAR (United Technologies Research Center, East Hartford, CT) Journal of Fluid Mechanics (ISSN 0022-1120); vol. 149, Dec. 1984, p. 403-429. refs (Contract NAS3-23696)

The unsteady airloads generated by the vibrations of turbomachine blades operating at transonic Mach numbers are predicted by a linearized potential flow analysis whose unsteady aerodynamics model encompasses the effects of blade geometry, nonzero mean pressure variation across the blade row, high frequency blade motion, and shock motion, all within the framework of a linearized frequency-domain formulation. A numerical solution for the entire unsteady flow field is determined by matching a solution covering an extended blade passage region to another covering, and extending beyond, the supersonic region(s) adjacent to a blade surface. Results are given for cascades of double circular arc and flat plate blades, in order to demonstrate the unsteady analysis and to partially illustrate the effects of blade geometry, inlet Mach number, vibration frequency and shock motion on unsteady response. O.C.

A85-20851*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

EULER COMPUTATIONS OF AGARD WORKING GROUP 07 AIRFOIL TEST CASES

T. H. PULLIAM and J. T. BARTON (NASA, Ames Research Center, Moffett Field, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 34 p. refs (AIAA PAPER 85-0018)

In an attempt to provide a set of accurate standard test problems for computational code developers, a series of inviscid airfoil test cases were chosen by the AGARD Working Group 07, a subpanel of the AGARD Fluid Dynamics Panel. The cases include three different airfoils at transonic to supersonic conditions. A large number of international experts responded in this effort with computations that have been contrasted for accuracy and consistency. This paper is a summary of the authors' contribution to this study. In particular, the important aspects of the solution process that made it possible to obtain the high level of accuracy needed in this study are stressed. Author

02 AERODYNAMICS

A85-20854# DRAG PREDICTION FOR PROJECTILES AND FINNED BODIES IN INCOMPRESSIBLE FLOW

W. P. WOLFE and W. L. OBERKAMPF (Sandia National Laboratory, Albuquerque, NM) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 13 p. refs
(Contract DE-AC04-76DP-00789)
(AIAA PAPER 85-0104)

A design method is presented for calculating the flow field and drag of bodies of revolution, with and without lifting surfaces, at zero angle of attack in incompressible flow. The body pressure distribution, viscous shear stress, and boundary layer separation point are calculated by a combination of a potential flow method and boundary layer techniques. The potential solution is obtained by modeling the body with an axial distribution of source/sink elements whose strengths vary linearly along their length. Both the laminar and turbulent boundary layer solutions use momentum integral techniques which have been modified to account for the effects of surface roughness. An existing technique for estimating the location of transition was also modified to include surface roughness. Empirical correlations are developed to estimate the base pressure coefficient on a wide variety of geometries. Body surface pressure distributions and drag predictions are compared with experimental data for artillery projectiles, conical bodies, bombs, and missiles. Very good agreement between the present method and experiment is obtained. Author

A85-20855*# Informatics General Corp., Palo Alto, Calif. NAVIER-STOKES COMPUTATIONS FOR EXOTIC AIRFOILS

T. J. BARTH (Informatics General Corp., Palo Alto, CA), T. H. PULLIAM, and P. G. BUNING (NASA, Ames Research Center, Moffett Field, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 17 p. refs
(AIAA PAPER 85-0109)

An efficient hyperbolic grid generator with improvements for handling sharp corners and concave surfaces is combined with an efficient and accurate Navier-Stokes flow solver. This combination is applied to some rather complex two-dimensional airfoil configurations. Steady separated flow about an iced leading edge of an airfoil is presented. Unsteady viscous separated flows past an airfoil at two angles of attack with a spoiler deployed at 60 degrees are presented and compared with experiment. The spoiler computations are performed with two different topological maps of the physical domain to the computational domain. Innovative graphical techniques for both the static and unsteady display of the flow fields are presented and discussed. Author

A85-20862# AN EXPERIMENTAL INVESTIGATION OF THE MIXING OF CO-ANNULAR SWIRLING FLOWS

J. D. MATTINGLY (U.S. Air Force Academy, Colorado Springs, CO) and G. C. OATES (Washington, University, Seattle, WA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 10 p. refs
(Contract AF-AFOSR-80-0186G)
(AIAA PAPER 85-0186)

An extensive investigation of the mixing behavior of co-annular streams, with swirl present, has been carried out. A large blowdown facility was adapted to provide two streams of air at variable stagnation pressures, but equal stagnation temperatures. Conditions within the mixing region were essentially incompressible. The facility was constructed to provide swirl in the inner stream, and an inner and outer annulus could be provided if desired. In all cases considered, swirl was present in the inner, but not the outer stream, thereby leading to flow conditions unstable to the Rayleigh instability. Mean flow measurements, only, were obtained. A five hole probe was used to obtain the static pressure, stagnation pressure and three velocity components. Additional measurements included sidewall pressure measurements on the inner and outer annuli, as well as stream mass flow rates obtained from orifice plate meters. A variety of flow regimes were considered, including

some without separated regions present. Where possible, the results were compared to the somewhat limited data available in the literature. Author

A85-20864# FINITE ELEMENT SOLUTIONS OF EULER EQUATIONS FOR LIFTING AIRFOILS

H. U. AKAY, A. ECER, and P. G. WILLHITE (Purdue University, Indianapolis, IN) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 13 p. refs
(Contract F49620-83-K-0034)
(AIAA PAPER 85-0294)

A Clebsch formulation of Euler equations which includes the isentropic potential as well as the nonisentropic potential assumptions as special cases is reviewed. The applications to transonic flows around lifting airfoils are considered. The implementation of the Kutta condition at the sharp trailing edges for potential and Euler equations is presented. The differences for all three levels of approximations: isentropic potential, nonisentropic potential and full Euler, are demonstrated. Author

A85-20868*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

RECENT IMPROVEMENTS IN EFFICIENCY, ACCURACY, AND CONVERGENCE FOR IMPLICIT APPROXIMATE FACTORIZATION ALGORITHMS

T. H. PULLIAM and J. L. STEGER (NASA, Ames Research Center, Moffett Field, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 38 p. refs
(AIAA PAPER 85-0360)

In 1977 and 1978, general purpose centrally space differenced implicit finite difference codes in two and three dimensions have been introduced. These codes, now called ARC2D and ARC3D, can run either in inviscid or viscous mode for steady or unsteady flow. Since the introduction of the ARC2D and ARC3D codes, overall computational efficiency could be improved by making use of a number of algorithmic changes. These changes are related to the use of a spatially varying time step, the use of a sequence of mesh refinements to establish approximate solutions, implementation of various ways to reduce inversion work, improved numerical dissipation terms, and more implicit treatment of terms. The present investigation has the objective to describe the considered improvements and to quantify advantages and disadvantages. It is found that using established and simple procedures, a computer code can be maintained which is competitive with specialized codes. G.R.

A85-20869*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

A NUMERICAL SIMULATION OF THE NFAC (NATIONAL FULL-SCALE AERODYNAMICS COMPLEX) OPEN-RETURN WIND TUNNEL INLET FLOW

U. K. KAUL (NASA, Ames Research Center, Moffett Field; Informatics General Corp., Palo Alto, CA), J. C. ROSS (NASA, Ames Research Center, Moffett Field, CA), and J. L. JACOBS (Calspan Field Services, Inc., Arnold Air Force Station, TN) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 15 p. refs
(AIAA PAPER 85-0437)

The flow into an open return wind tunnel inlet was simulated using Euler equations. An explicit predictor-corrector method was employed to solve the system. The calculation is time-accurate and was performed to achieve a steady-state solution. The predictions are in reasonable agreement with the experimental data. Wall pressures are accurately predicted except in a region of recirculating flow. Flow-field surveys agree qualitatively with laser velocimeter measurements. The method can be used in the design process for open-return wind tunnels. Author

A85-20870*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

ARTIFICIAL DISSIPATION MODELS FOR THE EULER EQUATIONS

T. H. PULLIAM (Nasa, Ames Research Center, CFD Branch, Moffett Field, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 23 p. refs

(AIAA PAPER 85-0438)

Various artificial dissipation models which are used with central difference algorithms for the Euler equations are analyzed for their effect on accuracy, stability and convergence rates. In particular, linear and nonlinear models are investigated using an implicit approximate factorization code (ARC2D) for transonic airfoils. Fully implicit application of the dissipation models is shown to improve robustness and convergence rates. The treatment of dissipation models at boundaries will be examined. It will be shown that accurate, error free solutions with sharp shocks can be obtained using a central difference algorithm coupled with an appropriate nonlinear artificial dissipation model. Author

A85-20873*# Arizona State Univ., Tempe.

EXPERIMENTS ON THE STABILITY OF CROSSFLOW VORTICES IN SWEEP-WING FLOWS

W. S. SARIC (Arizona State University, Tempe, AZ) and L. G. YEATES (Lockheed-Georgia Co., Marietta, GA; Virginia Polytechnic Institute and State University, Blacksburg, VA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 14 p. refs

(Contract NAG1-280)

(AIAA PAPER 85-0493)

Experiments are conducted which demonstrate the feasibility of creating crossflow vortices in a flat-plate flow. A swept leading edge and contoured wind-tunnel walls produce a strong pressure gradient and a typical swept-wing flow on the plate. Detailed three-dimensional measurements, made within the boundary layer using hot-wire anemometry, are supplemented with different flow-visualization techniques. Data are presented on the mean flow characteristics as well as on the behavior of the crossflow vortices. Comparisons are made with theoretical flow-field and stability calculations. Author

A85-20998#

DRAW OF THE FUNDAMENTAL SHAPES OF PARACHUTES

M. HAYASHI, S. ASO, S.-I. TENHIRO, and H. NAKAYA (Kyushu University, Fukuoka, Japan) Kyushu University, Technology Reports (ISSN 0023-2718), vol. 57, Aug. 1984, p. 463-470. In Japanese, with abstract in English.

To investigate the drag of the fundamental shapes of parachutes, two-dimensional and three-dimensional concave bodies with various skirts, various slits, or various vents are prepared. The drag of these models has been measured and the flow around them has been visualized with smoke-wire technique. From the experiments above, the following results are obtained. For the three-dimensional concave body, whose cross section is semi-circle, the drag decreases significantly when a skirt of height ratio, h/d , 0.4 is attached to the model. For the two-dimensional circular body with slit, the drag drops sharply at first and decreases linearly at the porosity, β , of the slits increases. For the two-dimensional elliptic bodies, it is found that the slit around the top of the model is most effective to the drag of the model. For the three-dimensional concave bodies with slits and a vent the drag decreases more significantly with the porosity of the vent than with that of the slit. The results show that the drag of the parachute can be controlled to some degree by changing the porosity of the vent. Author

A85-21656

HARMONIC OSCILLATIONS OF A RECTANGULAR WING WITH A CIRCULATION VARIABLE OVER THE SPAN [GARMONICHESKIE KOLEBANIYA PRIAMOUGOL'NOGO KRYLA S TSIRKULIATSIEI PEREMENNOI PO RAZMAKHU]

N. N. POLIAKHOV and Z. N. SHESTERNINA Leningradskii Universitet, Vestnik, Matematika, Mekhanika, Astronomiia (ISSN 0024-0850), Oct. 1984, p. 44-50. In Russian.

Birnbaum's vortex scheme is used to obtain a solution to the problem of the small harmonic oscillations of a slightly curved rectangular-planform wing in the translational flow of an ideal incompressible fluid. The problem is reduced to the solution of a Fredholm equation of the second kind. B.J.

A85-21827*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

INTRODUCTORY AEROTHERMODYNAMICS OF ADVANCED SPACE TRANSPORTATION SYSTEMS

J. T. HOWE (NASA, Ames Research Center, Moffett Field, CA) Journal of Spacecraft and Rockets (ISSN 0022-4650), vol. 22, Jan.-Feb. 1985, p. 19-26. Previously cited in issue 05, p. 585, Accession no. A83-16695. refs

A85-21830*# PEDA Corp., Palo Alto, Calif.

REAL-GAS FLOWFIELDS ABOUT THREE-DIMENSIONAL CONFIGURATIONS

A. BALAKRISHNAN, C. K. LOMBARD (PEDA Corp., Palo Alto, CA), and W. C. DAVY (NASA, Ames Research Center, Moffett Field, CA) Journal of Spacecraft and Rockets (ISSN 0022-4650), vol. 22, Jan.-Feb. 1985, p. 46-53. Previously cited in issue 05, p. 591, Accession no. A83-17931. refs

A85-21841#

GROUND INTERFERENCE EFFECTS ON SUBSONIC DYNAMIC STALL IN PITCH AND PLUNGE

L. E. ERICSSON and J. P. REDING (Lockheed Missiles and Space Co., Inc., Sunnyvale, CA) (Structures, Structural Dynamics and Materials Conference, 24th, Lake Tahoe, NV, May 2-4, 1983, Collection of Technical Papers. Part 2, p. 266-276) Journal of Aircraft (ISSN 0021-8669), vol. 22, Feb. 1985, p. 109-116. Previously cited in issue 12, p. 1697, Accession no. A83-29836. refs

A85-21845#

ANALYSIS OF A SPLIT-FLOW INERTIAL PARTICLE SEPARATOR BY FINITE ELEMENTS

D. S. BREITMAN, E. G. DUECK (Pratt and Whitney Canada, Mississauga, Ontario, Canada), and W. G. HABASHI (Pratt and Whitney Canada, Mississauga, Ontario; Concordia University, Montreal, Canada) (Numerical methods in laminar and turbulent flow; Proceedings of the Third International Conference, Seattle, WA, August 8-11, 1983, p. 477-488) Journal of Aircraft (ISSN 0021-8669), vol. 22, Feb. 1985, p. 135-140. Previously cited in issue 03, p. 255, Accession no. A84-13278. refs

A85-21848*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

EVALUATION OF A STALLED AIRFOIL ANALYSIS PROGRAM

C. L. RUMSEY (NASA, Langley Research Center, Analytical Methods Branch, Hampton, VA) Journal of Aircraft (ISSN 0021-8669), vol. 22, Feb. 1985, p. 156, 157.

The Stalled Airfoil Analysis Program (SAAP) is a computer code for predicting the aerodynamic characteristics of an airfoil up to, and beyond, stall. SAAP is presently evaluated through comparisons with experiments and with two other theoretical methods over an extensive range of airfoils and Reynolds number conditions. SAAP modeled drag more accurately than either of the other methods, and at angles of attack below stall yielded a smoother lift variation with angle of attack. O.C.

02 AERODYNAMICS

A85-21849#

EXPERIMENTAL RESULTS FOR REYNOLDS NUMBER EFFECTS ON TRAILING VORTICES

H. LEE and J. A. SCHETZ (Virginia Polytechnic Institute and State University, Blacksburg, VA) *Journal of Aircraft* (ISSN 0021-8669), vol. 22, Feb. 1985, p. 158-160. Abridged. Previously cited in issue 17, p. 2458, Accession no. A83-38694.

A85-21851#

THE UNIVERSAL NATURE OF ZERO-CROSSING TIME AND VELOCITY SCALES IN TURBULENT SHEAR FLOWS

P. BANDYOPADHYAY (Systems and Applied Sciences Corp., Hampton, VA) and A. K. M. F. HUSSAIN (Houston, University, Houston, TX) *AIAA Journal* (ISSN 0001-1452), vol. 23, Feb. 1985, p. 161, 162.

Recent studies have shown that the turbulence production process in shear flows is not entirely random, but rather quasiperiodic in nature. Since the large eddies play a decisive role in these processes in all shear flows, it is instructive to see if they bear any common characteristics. The possible universal distributions of time and velocity scales (T , u sub p) in the low-frequency component of the turbulent signals (defined, respectively, as the interval between successive zero crossings and the intervening absolute peak value of the longitudinal velocity signal) have been explored in a number of flows. These include the self-preserving regions of a turbulent boundary layer, plane jet, circular jet, and plane mixing layer, and the initial mixing regions of a plane jet and circular jet. Both T and u sub p distributions show universal trends: T distributions agree well with the log normal distribution except in their extreme excursions, whereas u sub p distributions are intermediate between log normal and Gaussian distributions. Author

A85-21855#

MODES OF SHOCK-WAVE OSCILLATIONS ON SPIKE-TIPPED BODIES

W. CALARESE and W. L. HANKEY (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) *AIAA Journal* (ISSN 0001-1452), vol. 23, Feb. 1985, p. 185-192. Previously cited in issue 05, p. 587, Accession no. A83-16779. refs

A85-21856*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

SHOCK-FITTING SOLUTION OF THE SUPERSONIC FLOWFIELD IN A ROUNDED INTERNAL CORNER

J. A. MARTIN (NASA, Langley Research Center, Space Systems Div., Hampton, VA) *AIAA Journal* (ISSN 0001-1452), vol. 23, Feb. 1985, p. 193-200. Previously cited in issue 05, p. 578, Accession no. A83-16478. refs

A85-21857#

FLOWFIELD SCALING IN SHARP FIN-INDUCED SHOCK WAVE/TURBULENT BOUNDARY-LAYER INTERACTION

D. S. DOLLING (Texas, University, Austin, TX; Princeton University, Princeton, NJ) and W. B. MCCLURE (USAF, Aeronautical Systems Div., Wright-Patterson AFB, OH) *AIAA Journal* (ISSN 0001-1452), vol. 23, Feb. 1985, p. 201-206. Previously cited in issue 17, p. 2446, Accession no. A83-37227. refs (Contract F49620-81-K-0018)

A85-21859#

COMPUTATION OF CHOKED AND SUPERSONIC TURBOMACHINERY FLOWS BY A MODIFIED POTENTIAL METHOD

W. G. HABASHI (Concordia University, Montreal; Pratt and Whitney Canada, Longueuil, Quebec, Canada), M. M. HAFEZ (Computer Dynamics, Inc., Virginia Beach, VA; Pratt and Whitney Canada, Longueuil, Quebec, Canada), and P. L. KOTIUGA (Pratt and Whitney Canada, Longueuil, Quebec, Canada) *AIAA Journal* (ISSN 0001-1452), vol. 23, Feb. 1985, p. 214-220. Research supported by Pratt and Whitney Canada; Natural Sciences and Engineering Research Council of Canada. Previously cited in issue 16, p. 2296, Accession no. A83-36415. refs (Contract NSERC-A-3662)

A85-21864*# General Electric Co., Lynn, Mass.

SHOCK-FREE TURBOMACHINERY BLADE DESIGN

P. P. BEAUCHAMP (General Electric Co., Lynn, MA) and A. R. SEEBASS (Colorado, University, Boulder, CO) *AIAA Journal* (ISSN 0001-1452), vol. 23, Feb. 1985, p. 249-253. NASA-USAF-Navy-supported research. refs

A computational method for designing shock-free, quasi-three-dimensional, transonic, turbomachinery blades is described. Shock-free designs are found by implementing Sobieczky's fictitious gas principle in the analysis of a baseline shape, resulting in an elliptic solution that is incorrect in the supersonic domain. Shock-free designs are obtained by combining the subsonic portion of this solution with a characteristic calculation of the correct supersonic flow using the sonic line data from the fictitious elliptic solution. This provides a new, shock-free blade design. Examples presented include the removal of shocks from two blades in quasi-three-dimensional flow and the development of a series of shock-free two-dimensional stators. The new designs all include modifications to the upper surface of an experimental stator blade developed at NASA Lewis Research Center. While the designs presented here are for inviscid flow, the same concepts have been successfully applied to the shock-free design of airfoils and three-dimensional wings with viscous effects. The extension of the present method to viscous flows is straightforward given a suitable analysis algorithm for the flow. Author

A85-22146

INVESTIGATIONS OF THE LONGITUDINAL FLOW IN CORNER CONFIGURATIONS IN THE HYPERSONIC REGIME. II - CORNERS BETWEEN SWEEPED WEDGES [UNTERSUCHUNGEN AN LAENGSTANGESTROEMTEN ECKENKONFIGURATIONEN IM HYPERSCHALLBEREICH. II - ECKEN ZWISCHEN GEFPEILTEN KEILEN]

W. MOELLENSTAEDT (IVM, Wolfsburg GmbH, West Germany) *Zeitschrift fuer Flugwissenschaften und Weltraumforschung* (ISSN 0342-068X), vol. 8, Nov.-Dec. 1984, p. 405-414. In German. Research supported by the Deutsche Forschungsgemeinschaft. refs

Hypersonic flight vehicles are exposed to considerable thermal stresses due to kinetic heating. High-level heat transfer processes occur also in corner regions of wing-fuselage junctions or propulsion system inlets. The present investigation is concerned with a systematic study of the longitudinal flow in such corner regions, taking into account a comprehensive experimental program initiated at a West German technical university a number of years ago. One part of this study has been discussed by Kipke and Hummel (1975). The second part provides the results of an investigation of the flow in swept corner configurations, giving attention to conditions involving a free-stream Mach number of 12.3 and a Reynolds number of 500,000. The characteristics of the corner flow are illustrated in a graph. The flowfield at a swept 90 deg corner is considered along with the effect of the leading edge sweep angle on the flow, and the effect of the corner angle on the flow. A leading edge sweep angle of 60 deg is found to lead to a significant reduction of the heat flux. G.R.

A85-22227#**FLIGHT TESTING OF A WING SECTION WITH LAMINAR FLOW CONTROL**

R. B. DAMANIA (National Aeronautical Laboratory; Indian Institute of Science, Bangalore, India) and N. S. W. THOMAS (Lockheed-Georgia Co., Advanced Flight Sciences Dept., Marietta, GA) Aeronautical Society of India, Journal (ISSN 0001-9267), vol. 36, May 1984, p. 95-106. refs

Tests with a laminar flow control (LFC) wing glove over the using of a Caproni powered glide are discussed, with emphasis on the instrumentation and measurement methods used. The glove profile provided a pressure distribution resembling that on a large transonic LFC transport in the cruise condition; the five slots in the upper surface of the glove ensured Reynolds numbers less than 100. The techniques used included surface Preston tubes, surface microphones, boundary layer rakes, and naphthalene sprays for flow visualization. The Preston tube technique is noted to be the easiest in use and most repeatable. Boundary layer transition studies suggest that a greater shift in transition can be obtained if the suction is concentrated near the leading edge region rather than being distributed over the wing. L.T.

A85-22228#**DESIGN OF LIFTING SYMMETRIC SUPERCRITICAL AIRFOILS**

M. NANDANAN and M. A. RAMASWAMY (National Aeronautical Laboratory, Bangalore, India) Aeronautical Society of India, Journal (ISSN 0001-9267), vol. 36, May 1984, p. 107-113. refs

The design of a symmetric supercritical airfoil (SSA), shock-free under lifting conditions, is feasible through an example of a modified NACA-0012 airfoil. Off-design performance comparison at a freestream Mach number of 0.752 and an incidence angle of 1.1 degrees indicates the superiority of the derivative over the original NACA-0012 airfoil. Zero camber of the airfoil eliminates the wave drag penalty at supersonic speeds, thus making possible the airfoil application to combat aircraft and helicopter rotors. A table containing NAL-114-36-00 SSA coordinates, and the comparison data of the buffet onset boundaries and pressure distribution are given. L.T.

A85-22308**FLOW BEHIND AN ATTACHED SHOCK WAVE IN A RADIATING GAS**

L. P. SINGH, A. KUMAR, and R. SHYAM (Banaras Hindu University, Varanasi, India) Astrophysics and Space Science (ISSN 0004-640X), vol. 106, no. 1, Nov. 1984, p. 81-92. refs

A simple method is used to determine the curvature of an attached shock wave and the flow variable gradients behind the shock curve at the tip of a straight-edged wedge placed symmetrically in a supersonic flow of a radiating gas near the optically thin limit. The shock curvature and the flow variable gradients along the wedge at the tip are computed for a wide range of upstream flow Mach numbers and wedge angles. Several interesting results are noted; in particular, it is found that the effect of an increase in the upstream flow Mach number or the radiative flux is to enhance the shock wave curvature which, however, decreases with an increase in the specific heat ratio or the wedge angle. Author

A85-22364**ILL-POSED PROBLEMS IN PERTURBATION THEORY (ASYMPTOTIC METHODS OF MECHANICS) [NEKORREKTYE ZADACHI TEORII VOZMUSHCHENII /ASIMPTOTICHESKIE METODY MEKHANIKI/]**

A. N. PANCHENKOV, ED. Novosibirsk, Izdatel'stvo Nauka, 1984, 248 p. In Russian. For individual items see A85-22365 to A85-22374.

Papers are presented concerning the application of asymptotic methods to the study of various ill-posed problems of mechanics, with a particular emphasis on problems of aerohydrodynamics (i.e., sea surface effect vehicles). Consideration is given to the development of asymptotic algorithms in the Polet software package for the design of sea surface effect vehicles; the full-approximation method in the theory of transonic flows;

approximation of solutions of the first extremum problem of a wing with constant sea surface effect; and the extremum problem of a wing with a maximum gradient of lift force. The extremum problem of the shape of a body of revolution in supersonic flow, the design of a STOL aircraft with jet assisted takeoff units, and the use of local functionals to construct a circumvention maneuver in game problems of evasion. B.J.

A85-22366**DEVELOPMENT OF ASYMPTOTIC ALGORITHMS IN THE POLET PACKAGE OF APPLICATIONS PROGRAMS [POSTROENIE ASIMPTOTICHESKIKH ALGORITMOV V PAKETE PRIKLADNYKH PROGRAMM 'POLET']**

A. N. PANCHENKOV, I. U. F. ORLOV, R. I. U. SHLAUSTAS, M. N. BORISIUK, G. I. ANTOSHKINA, and V. D. MISHCHENKO IN: Ill-posed problems in perturbation theory (A85-22364 08-02). Novosibirsk, Izdatel'stvo Nauka, 1984, p. 44-102. In Russian. refs

The Polet (Flight) software package has been developed for the optimal design of sea surface effect vehicles. Polet is described with respect to the theory and methodology of optimal design, package structure and function, and the following basic asymptotic methods: theory of maximum correctness, theory of acceleration potential, theory of wings in bounded steady and unsteady flows, quadrupole wing theory, and asymptotic programming. Particular attention is given to functional modules, the package languages, and general programs and schemes for the solution of large problems. B.J.

A85-22367**THE FULL-APPROXIMATION METHOD IN THE THEORY OF TRANSONIC FLOWS [METOD POLNOI APPROKSIMATSII V TEORII OKOLOZVUKOVYKH TECHENII]**

G. F. SIGALOV IN: Ill-posed problems in perturbation theory (A85-22364 08-02). Novosibirsk, Izdatel'stvo Nauka, 1984, p. 102-147. In Russian. refs

The paper describes the distinctive features of the full-approximation method (FAM), an asymptotic method for the analysis of boundary value problems in the theory of transonic flows. The FAM is applied to the study of a number of aerodynamic problems in the subsonic and supersonic parts of the transonic region, including: the steady motions of profiles in bounded or unbounded flows; low-frequency harmonic oscillations of a profile; and flow past a wing of rectangular planform. The application of the FAM to certain ill-posed problems of transonic flow is considered; particular emphasis is placed on the shape optimization of thin bodies. B.J.

A85-22368**APPROXIMATE SOLUTION OF A NONLINEAR PROBLEM OF FLOW PAST A THIN AIRFOIL PROFILE NEAR A SUPPORT SURFACE [PRIKLIZHENNOE RESHENIE NELINEINOI ZADACHI OBTAKANIIA TONKOGO PROFILIA VBLIZI OPORNOI POVERKHNOSTI]**

R. I. U. SHLAUSTAS IN: Ill-posed problems in perturbation theory (A85-22364 08-02). Novosibirsk, Izdatel'stvo Nauka, 1984, p. 167-174. In Russian. refs

Asymptotic quadrupole wing theory is used to obtain an approximate equation for flow past a thin airfoil at small distances from a flat solid surface. An approximate analytical solution to this equation is obtained, and the results are compared with previous data, indicating a good agreement in a large range of distances between the airfoil and surface, and in a large range of angles of attack. It is shown that a large lift is achieved at small local angles of attack of the entering edge of the airfoil. B.J.

02 AERODYNAMICS

A85-22370
EXTREMUM PROBLEM CONCERNING A WING WITH A MAXIMUM GRADIENT OF LIFT FORCE [EKSTREMAL'NAIA ZADACHA O KRYLE S MAKSIMAL'NYM GRADIENTOM POD'EMNOI SILY]

L. V. ARSHINSKII IN: Ill-posed problems in perturbation theory (A85-22364 08-02). Novosibirsk, Izdatel'stvo Nauka, 1984, p. 187-193. In Russian.

The paper examines the problem of selecting the three-dimensional geometry of a lifting surface in such a way as to provide for a maximum value of the modulus of the lift-force gradient with respect to the distance between the wing and a screen. The wing is assumed to move at quadrupolar distance from the screen, and the lift coefficient is determined on the basis of the theory of moderate near-screen perturbations. An extremum is obtained which coincides with the Euler extremum everywhere but at singular edges. B.J.

A85-22371
AN EXTREMUM PROBLEM CONCERNING THE SHAPE OF A BODY OF REVOLUTION IN SUPERSONIC GAS FLOW [ODNA EKSTREMAL'NAIA ZADACHA O FORME TELA VRASHCHENIIA V SVERKHZVUKOVOM POTOKE GAZA]

A. V. DANEEV IN: Ill-posed problems in perturbation theory (A85-22364 08-02). Novosibirsk, Izdatel'stvo Nauka, 1984, p. 194-199. In Russian. refs

The method of sources is used to solve an ill-posed problem concerning the shape optimization of a closed thin body of revolution, assuring minimum wave drag in linearized supersonic flow. A formula is obtained for the wave drag coefficient in the Mach number range of 1.5 to 6. B.J.

N85-15687*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
GROUND-EFFECT ANALYSIS OF A JET TRANSPORT AIRPLANE

R. E. CURRY and A. H. BOWERS Jan. 1984 12 p refs Presented at the 23rd AIAA Aerospace Sci. Meeting, Reno, Nev., 14-17 Jan. 1985

(NASA-TM-85920; H-1273; NAS 1.15:85920; AIAA-85-0307)

Avail: NTIS HC A02/MF A01 CSCL 01A

An analysis of the ground effect of a jet transport airplane has been made. Data were obtained from recent flight tests primarily using the constant angle-of-attack approach technique. Reasonable results were obtained for ground-effect pitching moment and lift increments. These were compared with data from other sources, including computations, wind tunnel, and previous flight test. A recommended ground-effect model was developed from the results. A brief simulator study was conducted to determine the sensitivity of a particular configuration to this ground-effect model and its associated uncertainty. Author

N85-15688*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

ANALYTICAL MODELING OF CIRCUIT AERODYNAMICS IN THE NEW NASA LEWIS WIND TUNNEL

C. E. TOWNE, L. A. POVINELLI, W. G. KUNIK, K. K. MURAMOTO, C. E. HUGHES, and R. LEVY (Scientific Research Associates) 1985 22 p refs Presented at the 23rd Aerospace Sci. Meeting, Reno, Nev., 14-17 Jan. 1985; sponsored by AIAA (NASA-TM-86912; E-2405; NAS 1.15:86912; AIAA-85-0380)

Avail: NTIS HC A02/MF A01 CSCL 01A

Rehabilitation and extension of the capability of the altitude wind tunnel (AWT) was analyzed. The analytical modeling program involves the use of advanced axisymmetric and three dimensional viscous analyses to compute the flow through the various AWT components. Results for the analytical modeling of the high speed leg aerodynamics are presented; these include: an evaluation of the flow quality at the entrance to the test section, an investigation of the effects of test section bleed for different model blockages, and an examination of three dimensional effects in the diffuser due to reentry flow and due to the change in cross sectional shape of the exhaust scoop. E.A.K.

N85-15689*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

UNSTEADY PRESSURE MEASUREMENTS ON A BICONVEX AIRFOIL IN A TRANSONIC OSCILLATING CASCADE

L. M. SHAW, D. R. BOLDMAN, A. E. BUGGELE, and D. H. BUFFUM (Purdue Univ.) 1985 18 p refs Proposed for presentation at the 30th Intern. Gas Turbine Conf. and Exhibit, Houston, Tex., 17-21 Mar. 1985; sponsored by the American Society of Mechanical Engineering

(NASA-TM-86914; E-2408; NAS 1.15:86914) Avail: NTIS HC A02/MF A01 CSCL 01A

Flush-mounted dynamic pressure transducers were installed on the center airfoil of a transonic oscillating cascade to measure the unsteady aerodynamic response as nine airfoils were simultaneously driven to provide 1.2 deg of pitching motion about the midchord. Initial tests were performed at an incidence and angle of 0 deg and A Mach number of 0.65 in order to obtain results in a shock-free compressible flowfield. Subsequent tests were performed at an incidence angle of 7 deg and Mach number of 0.8 in order to observe the surface pressures with an oscillating shock near the leading edge of the airfoil. Results are presented for interblade phase angles of 90 and -90 deg and at blade oscillatory frequencies of 200 and 500 Hz (semi-chord reduced frequencies up to about 0.5 at a Mach number of 0.8). Results from the zero-incidence cascade are compared with a classical unsteady flat-plate analysis. Flow visualization results depicting the shock motion on the airfoils in the high-incidence cascade are discussed. The airfoil pressure data are tabulated. Author

N85-15690*# Kansas Univ., Lawrence. Flight Research Lab.
AN INVESTIGATION OF VORTEX-INDUCED AERODYNAMIC CHARACTERISTICS OF SUPERSONIC CRUISE CONFIGURATIONS Semiannual Status Report, 1 Jul. - 31 Dec. 1984

C. E. LAN 28 Jan. 1985 14 p refs

(Contract NSG-1629)

(NASA-CR-174299; NAS 1.26:174299) Avail: NTIS HC A02/MF A01 CSCL 01A

The linear lifting surface theory which predicts the life in supersonic flow, even though the drag is usually underpredicted, is described. A method for calculating the nonlinear wave drag was developed to remedy this deficiency. The calculated sectional drag is modified by adding the difference between the exact two dimensional (2-D) and the linear 2-D wave drag at the calculated sectional lift coefficient. Improvement in the supersonic drag prediction is shown. The VORCAM code was modified for the FORTRAN 77 language and its input stream was rearranged. The Boeing code was adapted to the computer system. All CDC special features in the code are replaced with standard FORTRAN algorithms. It is suggested that because of the nonlinearity the solution appears to be nonunique crowding of two vortices, a mechanism of vortex asymmetry, is investigated. E.A.K.

N85-15691*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

LOADS AND AEROELASTICITY DIVISION RESEARCH AND TECHNOLOGY ACCOMPLISHMENTS FOR FY 1984 AND PLANS FOR FY 1985

J. E. GARDNER and S. C. DIXON Jan. 1985 162 p refs (NASA-TM-86356; NAS 1.15:86356) Avail: NTIS HC A08/MF A01 CSCL 01A

The loads and aeroelasticity divisions research accomplishments are presented. The work under each branch or technical area, described in terms of highlights of accomplishments during the past year and highlights of plans for the current year as they relate to 5 year plans for each technical area. This information will be useful in program coordination with other government organizations and industry in areas of mutual interest. E.A.K.

N85-15692*# Kansas Univ. Center for Research, Inc., Lawrence. Flight Research Lab.

DESIGN STUDY OF TECHNOLOGY REQUIREMENTS FOR HIGH PERFORMANCE SINGLE-PROPELLER-DRIVEN BUSINESS AIRPLANES Final Report

D. L. KOHLMAN and J. HAMMER Washington NASA Jan. 1985 105 p refs

(NASA-CR-3863; NAS 1.26:3863; KU-FRL-487-1) Avail: NTIS HC A06/MF A01 CSCL 01A

Developments in aerodynamic, structural and propulsion technologies which influence the potential for significant improvements in performance and fuel efficiency of general aviation business airplanes are discussed. The advancements include such technologies as natural laminar flow, composite materials, and advanced intermittent combustion engines. The design goal for this parameter design study is a range of 1300 nm at 300 knots true airspeed with a payload of 1200lbs at 35,000 ft cruise altitude. The individual and synergistic effects of various advanced technologies on the optimization of this class of high performance, single engine, propeller driven business airplanes are identified.

EAK

N85-15693*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

DOWNWASH IN THE PLANE OF SYMMETRY OF AN ELLIPTICALLY LOADED WING

J. D. PHILLIPS Jan. 1985 26 p refs

(NASA-TP-2414; A-9871; NAS 1.60:2414) Avail: NTIS HC A03/MF A01 CSCL 01A

A closed-form solution for the downwash in the plane of symmetry of an elliptically loaded line is given. This theoretical result is derived from Prandtl's lifting-line theory and assumes that: (1) a three-dimensional wing can be replaced by a straight lifting line, (2) this line is elliptically loaded, and (3) the trailing wake is a flat-sheet which does not roll up. The first assumption is reasonable for distances greater than about 1 chord from the wing aerodynamic center. The second assumption is satisfied by any combination of wing twist, spanwise camber variation, or planform that approximates elliptic loading. The third assumption is justified only for high-aspect-ratio wings at low lift coefficients and downstream distances less than about 1 span from the aerodynamic center. It is shown, however, that assuming the wake to be fully rolled up gives downwash values reasonably close to those of the flat-sheet solution derived in this paper. The wing can therefore be modeled as a single horseshoe vortex with the same lift and total circulation as the equivalent ellipticity loaded line, and the predicted downwash will be a close approximation independent of aspect ratio and lift coefficient. The flat-sheet equation and the fully rolled up wake equation are both one-line formulas that predict the upwash field in front of the wing, as well as the downwash field behind it. These formulas are useful for preliminary estimates of the complex aerodynamic interaction between two wings (i.e., canard, tandem wing, and conventional aircraft) including the effects of gap and stagger.

Author

N85-15694*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

A COMPARATIVE STUDY OF THE NONUNIQUENESS PROBLEM OF THE POTENTIAL EQUATION

M. D. SALAS, A. JAMESON (Princeton Univ., N.J.), and R. E. MELNIK (Grumman Aerospace Corp., Bethpage, N.Y.) Jan. 1985 23 p refs

(NASA-TP-2385; L-15682; NAS 1.60:2385) Avail: NTIS HC A02/MF A01 CSCL 01A

The nonuniqueness problem occurring at transonic speeds with the conservative potential equation is investigated numerically. The study indicates that the problem is not an inviscid phenomenon, but results from approximate treatment of shock waves inherent in the conservative potential model. A new bound on the limit of validity of the conservative potential model is proposed.

Author

N85-15695*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

AILERON EFFECTIVENESS FOR A SUBSONIC TRANSPORT MODEL WITH A HIGH-ASPECT-RATIO SUPERCritical WING

P. F. JACOBS Dec. 1983 277 p refs

(NASA-TM-85674; L-15646; NAS 1.15:85674) Avail: NTIS HC A13/MF A01 CSCL 01A

Aileron effectiveness for a subsonic energy efficient transport (EET) model with a high aspect ratio supercritical wing was determined in the 8-foot transonic pressure tunnel. Data are presented for ailerons located at three positions along the wing span. The ailerons were designed as a preliminary active control concept with gust load alleviation, maneuver load alleviation, and flutter suppression systems. A linear variation of rolling moment coefficient with angle of attack for individual and multiple aileron deflections at Mach numbers up to 0.81 is indicated. For Mach numbers greater than 0.81, the rolling moment coefficient data become nonlinear with increasing angle of attack. At Mach numbers near the design value increased aileron effectiveness resulted from aft transition locations, which produced relatively thin boundary layers and greater effective aileron deflections. Individual aileron deflections on the right wing panel produced only small effects on yawing moment and side force coefficients.

E.A.K.

N85-15696*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

AN EXPLORATORY STUDY OF FINITE DIFFERENCE GRIDS FOR TRANSONIC UNSTEADY AERODYNAMICS

D. A. SEIDEL, R. M. BENNETT, and W. WHITLOW, JR. Dec. 1982 39 p refs Presented at the 21st AIAA Aerospace Sci. Meeting, Reno, Nev., 10-13 Jan. 1983

(NASA-TM-84583; NAS 1.15:84583; AIAA-83-0503) Avail: NTIS HC A03/MF A01 CSCL 01A

Unsteady aerodynamic forces are calculated by the XTRAN2L finite difference program which solves the complete two dimensional unsteady transonic small perturbation equation. The unsteady forces are obtained using a pulse transfer function technique which assumes the flow field behaves in a locally linear fashion about a mean condition. Forces are calculated for a linear flat plate using the default grids from the LTRAN2-NLR, LTRAN2-HI, and XTRAN3S programs. The forces are compared to the exact theoretical values for flat plate, and grid generated boundary and internal numerical reflections are observed to cause significant errors in the unsteady airloads. Grids are presented that alleviate the reflections while reducing computational time up to fifty-three percent and program size up to twenty-eight percent. Forces are presented for a six percent thick parabolic arc airfoil which demonstrate that the transform technique may be successfully applied to nonlinear transonic flows.

Author

N85-15697*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

COMPARISON OF ANALYTICAL AND EXPERIMENTAL STEADY AND UNSTEADY-PRESSURE DISTRIBUTIONS AT MACH NUMBER 0.78 FOR A HIGH-ASPECT-RATIO SUPERCritical WING MODEL WITH OSCILLATING CONTROL SURFACES

W. E. MCCAIN Jan. 1984 56 p refs

(NASA-TM-84589; NAS 1.15:84589) Avail: NTIS HC A04/MF A01 CSCL 01A

The unsteady aerodynamic lifting surface theory, the Doublet Lattice method, with experimental steady and unsteady pressure measurements of a high aspect ratio supercritical wing model at a Mach number of 0.78 were compared. The steady pressure data comparisons were made for incremental changes in angle of attack and control surface deflection. The unsteady pressure data comparisons were made at set angle of attack positions with oscillating control surface deflections. Significant viscous and transonic effects in the experimental aerodynamics which cannot be predicted by the Doublet Lattice method are shown. This study should assist development of empirical correction methods that may be applied to improve Doublet Lattice calculations of lifting surface aerodynamics.

E.A.K.

02 AERODYNAMICS

N85-15699# Naval Air Development Center, Warminster, Pa. Aircraft and Crew Systems Technology Directorate.

ANALYSIS OF THE FLOW FIELD ABOUT A T-45 USING PANAIR Final Report

W. W. TSENG, R. LLORENS, and J. GARDNER May 1984 29 p
(AD-A146811; NADC-84077-60) Avail: NTIS HC A03/MF A01 CSCL 20D

It is the purpose of this report to document the work performed in utilizing the linear inviscid flow program called PANAIR on the analysis of the T-45 Hawk aircraft. This report summarizes the excellent agreement possible when using PANAIR to predict model pressure data in a wind tunnel at low Mach numbers. The Naval Air Development Center, under this IR program, is attempting to transition computational fluid dynamics research codes into practical and useful design/analysis tools. This report summarizes the work accomplished while utilizing PANAIR to predict the wing pressure distributions on the T-45 Hawk aircraft and then comparing these data to experimental wind tunnel results. The T-45 aircraft is part of a new Navy training system that will provide fixed wing jet flight training for intermediate and advanced phases of the Navy Integrated Flight Training System (NIFTS) to meet future pilot production requirements. Comparisons of the theoretical predictions obtained from PANAIR with experimental results show excellent agreement between the two data sets. GRA

N85-16240# Joint Publications Research Service, Arlington, Va. **PARACHUTE EXPEDITION TO ARCTIC**

N. SELIVANOR *In its* USSR Rept.: Earth Sci. (JPRS-UES-84-008) 106-108 13 Dec. 1984 Transl. into ENGLISH from Daily Rev. (Moscow), v. 30, no. 131, 29 Jun. 1984 p 1-4
Avail: NTIS HC A06

The technique of parachuting people and heavy cargo onto an ice floe in the Arctic is described. The challenges of establishing a floating research facility are discussed. Particular emphasis is placed upon runway construction which permits heavy aircraft to land and deliver essential supplies. R.S.F.

N85-16772# British Aerospace Aircraft Group, Weybridge (England).

RECENT PROGRESS OF DEVELOPMENT AND UNDERSTANDING OF HIGH LIFT SYSTEMS

D. J. BUTTER *In* AGARD Improvement of Aerodynamic Performance Through Boundary Layer Control and High Lift Systems 26 p Aug. 1984 refs
Avail: NTIS HC A18/MF A01

The mechanical high lift device as it is used for transport type aircraft is discussed. Current design approaches are reviewed along with progress on both the development of high lift device design and on the understanding of the related flow physics. Likely future developments and the fundamental research required to achieve them are also addressed. M.G.

N85-16773# Royal Aircraft Establishment, Farnborough (England). Aerodynamics Dept.

INVESTIGATIONS INTO THE EFFECTS OF SCALE AND COMPRESSIBILITY ON LIFT AND DRAG IN THE RAE 5M PRESSURIZED LOW-SPEED WIND TUNNEL

S. P. FIDDES, D. A. KIRBY, D. S. WOODWARD, and D. H. PECKHAM *In* AGARD Improvement of Aerodynamic Performance Through Boundary Layer Control and High Lift Systems 7 p Aug. 1984 refs
Avail: NTIS HC A18/MF A01

Results obtained from experiments in the RAE 5m low speed pressurized wind tunnel are presented. The tunnel is capable of operation over a range of pressures (from one to three atmospheres) so that the effects of Mach and Reynolds number may be separated. This decoupling of scale and compressibility effects makes possible reliable extrapolation of test results to full-scale conditions (where this is necessary) as well as giving greater insight into the underlying flow mechanisms. The large size of the tunnel, combined with pressurization to three atmospheres, enabled some tests, on small combat/trainer aircraft

and on bomb-like stores, to be carried out at full scale. Three facets of the work of the 5m tunnel are described: work aimed at predicting or improving the high lift performance of specific aircraft; work of a more fundamental nature concerned particularly with the optimization of high-lift devices on generalized research models; and work on the drag of stores carried externally on combat aircraft. Author

N85-16774# National Aerospace Lab., Amsterdam (Netherlands).

RECENT ADVANCES IN COMPUTATIONAL METHODS TO SOLVE THE HIGH-LIFT MULTI-COMPONENT AIRFOIL PROBLEM

B. OSKAM, D. J. LAAN, and D. F. VOLKERS *In* AGARD Improvement of Aerodynamic Performance Through Boundary Layer Control and High Lift Systems 31 p Aug. 1984 refs
Avail: NTIS HC A18/MF A01

Recent advances made in the analysis of viscous flow over high-lift multi component airfoil configurations are described. The calculation of viscous wakes subjected to large adverse pressure gradients is considered. The local supersonic flow over the slat of a high-lift configuration, with a free stream Mach number of around 0.2, is also addressed. Development of a computational method for turbulent wakes in adverse pressure gradient, including strong inviscid-viscous interaction, has improved the understanding of such phenomena as the off-the-surface pressure recovery capability of viscous wakes. The example of a wing with double-slotted flap shows that the wake, flowing into a region of higher pressure, may play a critical role that has not been recognized before. Results of the transonic panel method, solving the full potential equation, and the experimental data both show high local velocities reaching Mach numbers up to 1.6 at a free stream Mach number of 0.225. R.S.F.

N85-16775# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).

DETAILED STUDY OF THE FLOW AROUND A MULTI-ELEMENT AIRFOIL. COMPARISON WITH CALCULATIONS [ETUDE DETAILLEE DE L'ECOLEMENT AUTOUR D'UN PROFIL HYPERSUSTENTE COMPARAISONS AVEC LES CALCULS]

B. PORCHERON and J. J. THIBERT *In* AGARD Improvement of Aerodynamic Performance Through Boundary Layer Control and High Lift Systems 7 p Aug. 1984 refs *In* FRENCH; ENGLISH summary
Avail: NTIS HC A18/MF A01

Results are discussed for studies using a theoretical method for computing the viscous incompressible flow around multi-element airfoils as well as an experimental study of the flow around such configurations. The velocity profiles and the turbulence measurements around a multi-element airfoil clearly show the interaction between boundary-layer and wakes even when these are not merging and they have been used to draw accurate maps of the flow. The computing method of the flow around these configurations is based upon a panel method (both sources and vortices) for the inviscid part of the flow and a method providing calculation and coupling for boundary layers and wakes, under strong viscous interaction conditions. This method has given quite good results even when there are several simultaneous separated flow regions. The comparisons between computation and experiment described underline the necessity of improving the computing method in the region located above the flap. A.R.H.

N85-16776# Manchester Univ. (England). Dept. of the Mechanics of Fluids.

INVISCID COMPRESSIBLE FLOW PAST A MULTI-ELEMENT AEROFOIL

I. M. HALL and A. SUDDHOO *In* AGARD Improvement of Aerodynamic Performance Through Boundary Layer Control and High Lift Systems 15 p Aug. 1984 refs
Avail: NTIS HC A18/MF A01

A conformal transformation method is used to generate an orthogonal curvilinear grid for two and three-element airfoil configurations. The compressible potential flow equations are

solved by finite difference methods. The solution could serve as a starting point for an iterative solution of the full viscous compressible flow case. R.S.F.

N85-16783# Office National d'Etudes et de Recherches Aérospatiales, Toulouse (France).
APPLICATION OF TWO AND THREE-DIMENSIONAL CRITERIA FOR CALCULATING TRANSITIONS AND BOUNDARY LAYERS OVER SWEEPED WINGS

D. ARNAL and E. COUSTOLS /in AGARD Improvement of Aerodynamic Performance Through Boundary Layer Control and High Lift Systems 19 p Aug. 1984 refs In FRENCH; ENGLISH summary
 Avail: NTIS HC A18/MF A01

The possible origins of turbulence on an infinite swept wing are examined. A method for calculating the beginning of transition, and the transition region itself, is suggested for the three dimensional flow. The influence of sweep angle on transition and on drag coefficient of the airfoil and the efficiency of wall suction are discussed. E.A.K.

N85-16784# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (West Germany).
THEORETICAL STUDY OF BOUNDARY-LAYER CONTROL

E. H. HIRSCHEL /in AGARD Improvement of Aerodynamic Performance Through Boundary Layer Control and High Lift Systems 11p Aug. 1984 refs
 Avail: NTIS HC A18/MF A01

The inviscid flow past the upswept rear part of a fuselage is directed beneath the fuselage. This leads to an accumulation of boundary layer material at the lower side of the fuselage which might be prone to separation. The cross sections of the rear end of a typical transport airplane fuselage were modified from the original circles to rounded triangles, in this way shifting downward the centers of gravity of the cross sections. The side view contour, the width of the fuselage and the volume remain unchanged. Three different configurations without wing and tail unit were studied, the original and two modified ones. The inviscid flow was computed with the MBB panel method, the boundary layer development with the integral method of Cousteix and Aupoix for three dimensional turbulent, compressible flow. It is shown that less boundary layer material is transported under the rear part of the fuselage in the modified cases. The tendency of the skin friction lines to converge is reduced. The whole flow pattern at the base is improved. In the frame of boundary layer theory, however, no statement can be made about possible pressure drag reductions. An improvement of the elevator performance appears to be probable. The study shows that the upsweep of the fuselage is the main factor in the boundary layer development. The addition of the wing and the tail unit will only modify the picture. E.A.K.

N85-16785# Bochum Univ. (West Germany).
DRAG REDUCTION DUE TO BOUNDARY-LAYER CONTROL BY COMBINED BLOWING AND SUCTION

J. WIEDEMANN and K. GERSTEN /in AGARD Improvement of Aerodynamic Performance Through Boundary Layer Control and High Lift Systems 10p Aug. 1984 refs
 Avail: NTIS HC A18/MF A01

The boundary control system of combined blowing and suction was investigated. Blowing is applied in the front part of the body where the pressure gradient is favorable, whereas suction is applied in the rear part of the body where adverse pressure gradients exist. To avoid the sink drag the volume rate of suction should be equal or smaller than the blowing volume rate. Theoretical investigations of laminar flows include optimization of the blowing velocity distribution and second order boundary layer effects such as pressure drag and displacement effects on friction drag. Experimental results of turbulent boundary layers with very strong blowing velocities near the stagnation point of a circular cylinder are used as a basis of a simple prediction method. Experiments on a circular cylinder show considerable drag reductions due to the combined blowing and suction boundary layer control system. E.A.K.

N85-16787*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

TECHNOLOGY DEVELOPMENTS FOR LAMINAR BOUNDARY LAYER CONTROL ON SUBSONIC TRANSPORT AIRCRAFT

R. D. WAGNER, D. V. MADDALON, and M. C. FISCHER /in AGARD Improvement of Aerodynamic Performance Through Boundary Layer Control and High Lift Systems 13 p Aug. 1984 refs Previously announced in IAA as A84-33137
 Avail: NTIS HC A18/MF A01 CSCL 01A

The development of laminar flow technology for commercial transport aircraft is discussed and illustrated in a review of studies undertaken in the NASA Aircraft Energy Efficiency (ACEE) program since 1976. The early history of laminar flow control (LFC) techniques and natural laminar flow (NLF) airfoil designs is traced, and the aims of ACEE are outlined. The application of slotted structures, composites, and electron beam perforated metals in supercritical LFC airfoils, wing panels, and leading edge systems is examined; wind tunnel and flight test results are summarized; studies of high altitude ice effects are described; and hybrid (LFC/NLF) designs are characterized. Drawings and photographs are provided. (IAA)

N85-16788*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

TURBULENCE DRAG REDUCTION RESEARCH

D. M. BUSHNELL, J. B. ANDERS, M. J. WALSH, and R. V. MCINVILLE (North Carolina State Univ.) /in AGARD Improvement of Aerodynamic Performance Through Boundary Layer Control and High Lift Systems 13 p Aug. 1984 refs
 Avail: NTIS HC A18/MF A01 CSCL 01A

Research in the area of turbulent drag reduction for attached flows is summarized. The most promising passive techniques utilize non-planar geometry. Of particular interest is the suitability of these devices for retrofit of existing vehicles. Five methods for reducing turbulent skin friction drag on bodies/fuselages are discussed. They are: (1) large-eddy breakup devices; (2) riblets; (3) slot injection optimization; (4) control of Emmons spot generation; and (5) relaminarization through massive suction. Except for the Emmons spot work these methods all indicate the possibility of sizable net reductions in skin friction for laboratory conditions. B.W.

N85-16793# Office National d'Etudes et de Recherches Aérospatiales, Paris (France).

INTEREST OF INTERNAL BLEED FOR A TWO-DIMENSIONAL AIR INTAKE OPERATING IN A WIDE MACH NUMBER RANGE (1.8-3 PLUS)

G. LARUELLE, C. SANS, and R. LEFEBVRE (Société Nationale Industrielle Aérospatiale, Chatillon, France) /in AGARD Improvement of Aerodynamic Performance Through Boundary Layer Control and High Lift Systems 10 p Aug. 1984 refs In FRENCH; ENGLISH summary
 Avail: NTIS HC A18/MF A01

From a two-dimensional air intake with an internal bleed and optimized for approximately Mach number 2, a new configuration is sought allowing still good performance up to Mach number 3 plus, but with the minimum of movable parts. The main geometrical parameters are: the slope of the external compression ramp; the internal section law of the diffuser; and the inlet section of the internal bleed. The internal bleed and the advantage of a variable geometry are discussed, as well as the model which was built at large scale and its equipment; motorizations, measurement devices, and internal visualizations. The tests were performed in a supersonic wind tunnel. A movie shows shadowgraphs of the flow in the air intake geometrical throat, where the internal bleed is located, for several configuration changes (external ramp or diffuser wall rotations, increases of Mach number or angle of attack), and variable internal obstruction. Some results obtained with this air-intake model are explained. The choice of two configurations allowing correct performance in the studied Mach number range, by optimization of the internal bleed geometry, is commented on. R.J.F.

02 AERODYNAMICS

N85-16795# Messerschmitt-Boelkow-Blohm G.m.b.H., Bremen (West Germany).

ACTIVE AND PASSIVE SHOCK/BOUNDARY LAYER INTERACTION CONTROL ON SUPERCRITICAL AIRFOILS

P. THIEDE, P. KROGMANN (Deutsch Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen, West Germany), and E. STANEWSKY (Deutsch Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen, West Germany) In AGARD Improvement of Aerodynamic Performance Through Boundary Layer Control and High Lift Systems 13 p Aug. 1984 refs

Avail: NTIS HC A18/MF A01

Experimental investigations aiming at the improvement in the off-design performance of supercritical airfoils by active or passive control of the shock/boundary layer interaction (SBLI) through boundary layer suction in the shock region or ventilation respectively are presented. The experiments were carried out in a transonic wind tunnel using an advanced supercritical airfoil designed to have a largely fixed shock position at off-design conditions. The basic model was equipped with an exchangeable control device within the shock region of allow measurements with either surface clean, suction through a single slot, double slot or perforated strip, or ventilation through a double slot or perforated strip. The effectiveness of the different SBLI control methods is evaluated from surface pressure distribution, wake and boundary layer measurements, and Schlieren observations. It is shown that local boundary layer suction in the shock region mainly delays the shock-induced separation to greater shock strength and stabilizes the shock in its rearward position up to higher incidence, resulting in substantial improvements in the airfoil characteristics at off-design conditions. Without any suction a favorable passive effect is observed by boundary layer ventilation on the double slot and perforated strip configurations with a plenum underneath. A weakening of the shock wave results, offering a large potential for off-design drag reductions. R.J.F.

N85-16822 Illinois Univ., Urbana-Champaign.

AN OPTIMIZATION METHOD FOR THE PRELIMINARY DESIGN OF INTERPLANETARY AEROBRAKING MISSIONS Ph.D. Thesis

S. J. HOFFMAN 1984 161 p

Avail: Univ. Microfilms Order No. DA8422080

The use of atmospheric drag to circularize spacecraft orbits, a concept referred to as aerobraking, can significantly increase the useful payload mass fraction for various types of missions. A procedure is devised which determines the optimal combination of aerobrake shielding area and initial orbit period to maximize the spacecraft mass in the final orbit. Two computer codes are constructed and the results from each are compared. The first simulation assumes only aerodynamic drag perturbations and uses simplified analytical expressions. The second is a detailed numerical integration including perturbations due to drag, atmospheric rotation, planet oblateness, third-body effects, and solar radiation pressure. Hypersonic aerodynamic heating rate equations for two different shield configurations are discussed and their performances are compared. Illustrative numerical examples for a Venus and a Mars mission are included. Dissert. Abstr.

N85-16823 Michigan Univ., Ann Arbor.

SHOCK WAVES IN TRANSONIC FLOWS AT MODERATE REYNOLDS NUMBER Ph.D. Thesis

J. L. MACE 1984 244 p

Avail: Univ. Microfilms Order No. DA8422281

The behavior of shock waves in transonic flow with varying Reynolds and Prandtl numbers was examined using analytical and numerical methods. The method of matched asymptotic expansions was used to provide analytical solutions for both an inviscid and a viscous, thermally-conducting flow moving at transonic speeds in a symmetric channel. Also, analytical solutions were obtained for the structure of a shock wave in a viscous, thermally-conducting flow moving at transonic speeds about an airfoil. Finally, a finite-volume numerical method was used to provide solutions to inviscid, transonic flows in a channel. It was shown that, to the

accuracy desired, the location of the sonic line within the structure of a shock wave is independent of Reynolds number and, thus, coincident with the location of the corresponding discontinuous wave in the limit as Reynolds number tends to infinity. Also, in a numerical solution, truncation errors and artificial viscosity produce a smeared shock wave which is similar to that found in a flow at moderate Reynolds number. Dissert. Abstr.

N85-16825*# Atlanta Univ., Ga.

RANDOM EQUATIONS IN AERODYNAMICS Semiannual Progress Report, 1 Oct. 1983 - 1 Apr. 1984

A. T. BHARUCHA-REID 1 Apr. 1984 3 p

(Contract NAG1-413)

(NASA-CR-174279; NAS 1.26:174279) Avail: NTIS HC A02/MF A01 CSCL 01A

Literature was reviewed to identify aerodynamic models which might be treated by probabilistic methods. The numerical solution of some integral equations that arise in aerodynamical problems were investigated. On the basis of the numerical studies a qualitative theory of random integral equations was developed to provide information on the behavior of the solutions of these equations (in particular, boundary and asymptotic behavior, and stability) and their statistical properties without actually obtaining explicit solutions of the equations. B.G.

N85-16826*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

HELICOPTER MODEL ROTOR-BLADE VORTEX INTERACTION IMPULSIVE NOISE: SCALABILITY AND PARAMETRIC VARIATIONS

W. R. SPLETTSTOESSER (DFVLR, Brunswick), K. J. SCHULTZ (DFVLR, Brunswick), D. A. BOXWELL, and F. H. SCHMITZ Dec. 1984 31 p refs Prepared in cooperation with Army Research and Technology Labs., Moffett Field, Calif.

(NASA-TM-86007; A-9854; NAS 1.15:86007; TM-84-A-7) Avail: NTIS HC A03/MF A01 CSCL 01A

Acoustic data taken in the anechoic Deutsch-Niederlaendischer Windkanal (DNW) have documented the blade vortex interaction (BVI) impulsive noise radiated from a 1/7-scale model main rotor of the AH-1 series helicopter. Averaged model scale data were compared with averaged full scale, inflight acoustic data under similar nondimensional test conditions. At low advance ratios ($\mu = 0.164$ to 0.194), the data scale remarkably well in level and waveform shape, and also duplicate the directivity pattern of BVI impulsive noise. At moderate advance ratios ($\mu = 0.224$ to 0.270), the scaling deteriorates, suggesting that the model scale rotor is not adequately simulating the full scale BVI noise; presently, no proved explanation of this discrepancy exists. Carefully performed parametric variations over a complete matrix of testing conditions have shown that all of the four governing nondimensional parameters - tip Mach number at hover, advance ratio, local inflow ratio, and thrust coefficient - are highly sensitive to BVI noise radiation. Author

N85-16829*# Missouri Univ., Rolla. Dept. of Mechanical and Aerospace Engineering.

AERODYNAMIC-STRUCTURAL STUDY OF CANARD WING, DUAL WING, AND CONVENTIONAL WING SYSTEMS FOR GENERAL AVIATION APPLICATIONS Final Report

B. P. SELBERG and D. L. CRONIN Feb. 1985 87 p refs

(Contract NAG1-26)

(NASA-CR-172529; NAS 1.26:172529) Avail: NTIS HC A05/MF A01 CSCL 01A

An analytical aerodynamic-structural airplane configuration study was conducted to assess performance gains achievable through advanced design concepts. The mission specification was for 350 mph, range of 1500 st. mi., at altitudes between 30,000 and 40,000 ft. Two payload classes were studied - 1200 lb (6 passengers) and 2400 lb (12 passengers). The configurations analyzed included canard wings, closely coupled dual wings, swept forward - swept rearward wings, joined wings, and conventional wing tail arrangements. The results illustrate substantial performance gains possible with the dual wing configuration. These gains result from

weight savings due to predicted structural efficiencies. The need for further studies of structural efficiencies for the various advanced configurations was highlighted. Author

N85-16832# Nielsen Engineering and Research, Inc., Mountain View, Calif.

PREDICTION OF CRUCIFORM ALL-MOVABLE CONTROL CHARACTERISTICS AT TRANSONIC SPEEDS Final Technical Report, 1 Jan. 1983 - 31 Mar. 1984

J. N. NIELSEN, F. K. GOODWIN, and M. F. E. DILLENUS Mar. 1984 258 p

(Contract N00014-81-C-0267; F41-411)

(AD-A147291; NEAR-TR-321) Avail: NTIS HC A12/MF A01 CSCL 20D

A study has been made of the feasibility of developing a transonic hinge-moment prediction method for cruciform all-movable controls by correlating an extensive data base using the equivalent angle of attack concept. Body vortex effects have been handled using a simplified vortex model. Existing data from the Army generalized missile have been studied to examine transonic nonlinearities including pitch-yaw coupling and fin-fin control interference. Data for an aspect ratio 3.53, taper ratio 0.06 canard fin have been successfully correlated on the basis of the equivalent angle-of-attack concept. Data for an aspect ratio 2 delta fin mounted aft on the triservice missile have also been studied for angle of attack to 20% for Mach numbers of 0.8 and 12. Methods of extending the range of applicability of a previous hinge-moment prediction method have been developed. Desirable future extensions have been pointed out. GRA

N85-16833# Aeronautical Research Labs., Melbourne (Australia).

CALCULATION OF THE VELOCITY FIELD GENERATED BY A HELICOPTER MAIN AND TAIL ROTORS IN HOVER

K. J. HAYMAN and K. R. REDDY Jul. 1984 19 p

(AD-A147731; ARL-AERO-TM-366) Avail: NTIS HC A02/MF A01 CSCL 20D

A theory is presented to calculate the flow field due to main and tail rotors of a helicopter in hovering flight. To solve this complex flow problem, simple vortex rings are used to model main and tail rotor wakes. Preliminary numerical results are found to be encouraging. Author (GRA)

N85-16834# Rockwell International Corp., Los Angeles, Calif. North American Aircraft Operations.

JOINED WING TRANSONIC DESIGN AND TEST VALIDATION Final Report, 30 Sep. 1982 - 31 May 1984

J. A. CLYDE, E. BONNER, T. P. GOEBEL, and L. SPACHT 22 Jun. 1984 158 p

(Contract N00014-82-C-0601; NR PROJ. 212-276)

(AD-A148355; NA-84-1434) Avail: NTIS HC A08/MF A01 CSCL 20D

A tactical supercritical flow research model was designed to achieve high aerodynamic efficiency at Mach number 0.90 and lift coefficient 0.50 using numerical transonic design procedures. A wind tunnel model was built and tested in the Rockwell International Trisonic Wind Tunnel at Mach numbers of 0.40, 0.85, 0.90, 0.95. Lift-drag ratio at the design condition compared favorably with theoretical upper bound levels for the test arrangement and conditions. Six component force measurements for the joined wing are well behaved and near linear over an angle-of-attack range of $-4 < \alpha < 10$ degrees. Stable stall is naturally achieved for the arrangement. Weak changes in longitudinal and lateral-directional stability and control with pitch angle exist. GRA

N85-16835# Naval Surface Weapons Center, White Oak, Md. Underwater Systems Dept.

A THEORETICAL VIEW ON THE STRESS ANALYSIS OF FULLY INFLATED PARACHUTE CANOPIES

W. P. LUDTKE 28 May 1984 72 p

(AD-A148387; NSWC/TR-84-204) Avail: NTIS HC A04/MF A01 CSCL 01C

This report describes a theoretical approach to the analysis of the force distribution in fully inflated parachute canopies based upon the inflated gore mainseam shape. Normal and tangential forces for any arbitrary point along the gore mainseam can be determined and the magnitude and location of the maximum normal force and cloth stress evaluated. Methods, criteria, and rationale for calculating the force distributions are presented. GRA

N85-16836# Analytical Methods, Inc., Redmond, Wash.

PREDICTION OF DYNAMIC STALL CHARACTERISTICS USING ADVANCED NON-LINEAR PANEL METHODS Final Report, 1 Nov. 1982 - 17 Apr. 1984

B. MASKEW and F. A. DVORAK 4 Apr. 1984 63 p

(Contract F49620-82-C-0019)

(AD-A148453; AMI-8406; AFOSR-84-0975TR) Avail: NTIS HC A04/MF A01 CSCL 20D

A surface singularity panel method was extended for modeling the dynamic interaction between a separated wake and a surface undergoing an unsteady motion. The method combines the capabilities of an unsteady, time-stepping code and a technique for modeling extensive separation using free vortex sheets. Routines were developed for treating the dynamic interaction between the separated wake and the solid boundary in an environment where the separation point is moving with time. The behavior of these routines is being examined in a parallel effort using a two-dimensional pilot version of the three-dimensional pilot version of the three-dimensional code. This allows refinements in the procedures to be quickly developed and tested prior to installation into the main code. The extended code was coupled with an unsteady integral boundary layer method to examine the prediction of dynamic stall characteristics. The boundary layer code is accessed during the time-step cycle and provides the separation locations as well as the boundary layer displacement effect: the latter is modelled in the potential flow code using the source transpiration technique. The preliminary results include basic unsteady test cases for both the potential flow and boundary layer routines. GRA

N85-16838# Dornier-Werke G.m.b.H., Friedrichshafen (West Germany). Abt. Theoretische Aerodynamik.

THEORETICAL CONTRIBUTIONS TO TRANSONIC FLOW ANALYSIS FOR TRANSPORT AIRCRAFT Final Report, Dec. 1982

W. FRITZ, S. LEICHNER, W. SCHMIDT, and H. W. STOCK

Bonn Bundesministerium fuer Forschung und Technologie Oct. 1984 125 p refs In GERMAN; ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie

(BMFT-FB-W-84-036; ISSN-0170-1339) Avail: NTIS HC A06/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 26.50

Two and three dimensional computational methods were improved for the analysis of transonic aircraft. Viscous flow modeling and the analysis of unsteady transonic flow were emphasized. A fast method was developed for computation of viscous airfoil flow, and a finite volume method for general wing-body combinations, coupled with three-dimensional boundary-layer packages. Two and three-dimensional unsteady transonic flow solutions were derived for the analysis of flutter and active control devices. Author (ESA)

AIR TRANSPORTATION AND SAFETY

Includes passenger and cargo air transport operations; and aircraft accidents.

A85-19513#**SAFETY - METEOROLOGICAL DATA VITAL FOR SIMULATOR TRAINING**

J. T. KLEHR (Singer Co., Link Flight Simulation Div., Binghamton, NY) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 9 p. refs
(AIAA PAPER 85-0091)

Meteorological data and models currently in use in commercial transport aircraft simulators are reviewed and areas of possible improvements are indicated. Since modern simulators are computer-controlled and have six degrees of freedom in motion, the input of meteorological data such as that gathered during the JAWS experiment and with Doppler radar permits simulation of aircraft motion in response to wind shear and turbulence, provided sufficient computer power is available. The wind shear changes incorporate the effects of varying wind speed. The simulation attains higher realism when fed an input of high resolution meteorological numerical models, which also describe gusts and thunderstorm echoes. Further work and greater computer capacity is required to faithfully represent thunderstorm clouds, lightning strikes on and near aircraft, and icing hazards. M.S.K.

A85-19516#**THE LIGHTNING THREAT TO AEROSPACE VEHICLES**

P. L. RUSTAN, JR. (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 6 p. refs
(AIAA PAPER 85-0094)

During 1984 the United States Air Force Wright Aeronautical Laboratory and the Federal Aviation Administration conducted an in-flight lightning measurement program using a CV-580 aircraft in the vicinity of the Kennedy Space Center, FL. The aircraft was flown in thunderclouds where the regions of precipitation did not exceed 40 dBz between 2,000 and 18,000 feet. The aircraft was instrumented to measure the current flow on the wing tips, the normal and horizontal component of current density on the fuselage and on the wings, the electrostatic field, and the VHF radiation during direct lightning attachment. The transient electromagnetic characteristics of the lightning attachment were recorded by using six Tektronix 7612D waveform digitizers with a sample rate of 5 ns and a Honeywell 101 analog recorder with a 2 MHz frequency response. Data from 21 direct strike lightning attachment were recorded in the CV-580 aircraft during the program. The maximum rate of rise of the electric and magnetic flux density measured at the aircraft during direct lightning attachments were 22 A/sq m and 2950 T/s, respectively. This paper presents the characteristics of these fast pulses and the overall characteristics of the lightning flashes. Author

A85-19679#**THE DEVELOPMENT OF MATHEMATICAL MODELLING TECHNIQUES FOR HELICOPTER ROTOR ICING**

R. W. GENT and J. T. CANSDALE (Royal Aircraft Establishment, Farnborough, Hants., England) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 11 p. refs
(AIAA PAPER 85-0336)

Recent theoretical work at RAE on helicopter rotor icing and electrothermal deicing protection systems is presented. Mathematical models for the prediction of rotor ice accretion are described. These cover both droplet trajectories and the thermodynamic process of ice formation on an aerofoil in

compressible flow. Details are given of the development stages from the initial 2-dimensional hover model with non-conducting surface, through the inclusion of structural heat conduction, to a complete transient model which includes the effects of cyclic airspeed and pitch appropriate to a helicopter in forward flight. Significant progress has been made in the prediction of glaze ice shapes. The development of mathematical models for the prediction of temperature transients in rotors protected with an electrothermal deicing system is also described. The various stages of complexity achieved with both one and two dimensional models are discussed. Results showing typical output from the models are included.

Author

A85-19680#**CORRELATION OF AIRFOIL ICING RELATIONSHIPS WITH TWO-DIMENSIONAL MODEL AND FULL SCALE ROTORCRAFT ICING TEST DATA**

R. J. FLEMMING and D. A. LEDNICER (United Technologies Corp., Sikorsky Aircraft Div., Stratford, CT) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 16 p. refs
(AIAA PAPER 85-0337)

Tests have been conducted in a high-speed icing wind tunnel and a transonic airfoil facility to expand the data base on the performance of iced two-dimensional helicopter airfoils. It is found that generally, lift and drag increments vary linearly with liquid water content and icing time. Increasing Mach number has a greater effect on 12-pct-thick airfoils than on 9-pct-thick airfoils. The data have been generalized into a series of equations, providing predictions of ice thickness and force and moment coefficients with an accuracy of about 30 percent. The relationships have been incorporated into rotorcraft performance codes to give ice extent and torque rise information. V.L.

A85-19719#**EVALUATION OF AIRCRAFT INTERIOR PANELS UNDER FULL-SCALE CABIN FIRE TEST CONDITIONS**

C. P. SARKOS and R. G. HILL (FAA, Technical Center, Atlantic City, NJ) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 8 p. refs
(AIAA PAPER 85-0393)

Realistic full-scale fire tests demonstrated the potential safety benefits of advanced interior panels in transport aircraft, and displayed the characteristics of cabin fire hazards. The tests were conducted in a C-133 airplane, modified to resemble a wide-body interior, under postcrash and in-flight fire scenarios. The safety benefit of the advanced panel ranged from a 2-minute delay in the onset of flashover when the cabin fire was initiated by a fuel fire adjacent to a fuselage rupture, to the elimination of flashover when the fuel fire was adjacent to a door opening or when an in-flight fire was started from a seat drenched in gasoline. Analysis of the cabin hazards measured during postcrash fire tests indicated that the greatest threat to passenger survival was cabin flashover, and that toxic gases did not reach hazardous levels unless flashover occurred. Author

A85-19720# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

MEASUREMENTS OF THE RESPONSE OF TRANSPORT AIRCRAFT CEILING PANELS TO FUEL POOL FIRES

C. P. BANKSTON and L. H. BACK (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 10 p. NASA-supported research. refs
(AIAA PAPER 85-0394)

Tests were performed to characterize the responses of various aircraft ceiling panel configurations to a simulated post-crash fire. Attention was given to one currently used and four new ceiling configurations exposed to a fuel pool fire in a circulated air enclosure. The tests were controlled to accurately represent conditions in a real fire. The panels were constructed of

fiberglass-epoxy, graphite-phenolic resin, fiberglass-phenolic resin, Kevlar-epoxy, and Kevlar-phenolic resin materials. The phenolic resin-backed sheets performed the best under the circumstances, except when combined with Kevlar, which became porous when charred. M.S.K.

A85-19721#

THE THERMAL RESPONSE OF AIRCRAFT CABIN CEILING MATERIALS DURING A POST-CRASH, EXTERNAL FUEL-SPILL, FIRE SCENARIO

L. Y. COOPER (National Bureau of Standards, Center for Fire Research, Gaithersburg, MD) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 12 p. Research supported by the U.S. Department of Transportation and FAA. refs (AIAA PAPER 85-0395)

Aircraft cabin ceiling temperatures were measured in full scale simulated post-crash fire conditions. A C133A cargo aircraft with the wings and tail surfaces removed was employed in the trials, which featured burning JP-4 fuel and data gathered with fluxmeters and thermocouples in a seat and in the ceiling. Eight tests were performed and numerical models were formulated for thermal radiation from the doorway, seat, ceiling, and far away sources, convective heat transfer, and heat transfer from the upper ceiling surface. The resulting algorithm was validated in comparison with data from tests with several seats within the cabin. The algorithm is recommended for evaluating seat material and ceiling configurations considered in terms of their contributions to the fire safety of the aircraft. M.S.K.

A85-19768#

A SUMMARY OF NASA'S RESEARCH ON THE FLUID ICE PROTECTION SYSTEM

A. E. ALBRIGHT (General Dynamics Corp., Fort Worth, TX) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 14 p. refs (AIAA PAPER 85-0467)

One of the primary objectives of the considered investigations is related to a study of minimum anti-ice flow rates required in general aviation deicing systems on contemporary airfoils, taking into account the times required for deicing. Another objective is the presentation of two methods of predicting anti-ice flow rates, and their comparison with the wind tunnel results. Attention is given to the icing research tunnel and the wing models, the fluid ice protection system, the test techniques and procedures, stainless steel and titanium wing-panel configurations, a comparison of the new laser drilled titanium panel with the old stainless steel panel, the ADS-4 anti-ice flow rate prediction method, and an analytical method of predicting anti-ice flow rates. G.R.

A85-19846

ANALYSIS OF FATAL ACCIDENTS INVOLVING LIGHT AIRCRAFT WEIGHING UP TO TWO TONS AND THEIR CAUSES IN THE CONTEXT OF FLIGHT MEDICINE [ANALYSE VON TOEDLICHEN UNFAELLEN MIT LEICHTFLUGZEUGEN BIS ZU ZWEI TONNEN UND DEREN URSACHEN UNTER FLUGMEDIZINISCHEN ASPEKTEN]

K. BAYER Muenchen, Technische Universitaet, Fakultae fuer Medizin, Doktor der Medizin Dissertation, 1982, 85 p. In German. refs

All fatal accidents that occurred in the Federal Republic of Germany in aircraft weighing up to two tons during 1973-1977, a total of 104, have been evaluated in order to determine their causes. The human factor is emphasized, and the concepts of airflight medicine are used to probe the physiology of the sense organs of pilots and the parameters of competence to safely pilot an aircraft. Mechanical causes of accidents are also examined, the role of time of day and of flight phase in the generation of accidents. C.D.

A85-20148

WIND SHEAR - TAMING THE KILLER

D. BOYLE Interavia (ISSN 0020-5168), vol. 40, Jan. 1985, p. 65, 66.

The possible consequences of wind shear, particularly microburst, phenomena are described, and prediction and avoidance techniques are recommended, based on research by the UK Royal Aircraft Establishment (RAE) and the US Joint Airport Weather Studies. A microburst, described as a collision of two masses of air traveling at different speeds, can be simulated using a mathematical three-dimensional model developed by RAE with the intensity of the down-draught controlled up to an unsurvivable speed of 85 km, whereas most events observed are in the region of 40-60 km. A set of instructions for pilots is developed, tested in a DC-10 simulator for take-off and landing procedures. Wind shear detection and effective avoidance, obstructed by the phenomenon's infrequency, localization, and short duration, can be achieved by Doppler radar (not yet deployed extensively) and the Low Level Wind Shear Alert System developed in the US, which uses an arrangement of remote anemometers spaced throughout an airport to detect wind direction and velocity. L.T.

A85-20872*# Wichita State Univ., Kans.

ICING TUNNEL TESTS OF ELECTRO-IMPULSE DE-ICING OF AN ENGINE INLET AND HIGH-SPEED WINGS

G. W. ZUMWALT (Wichita State University, Wichita, KS) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 8 p. refs (Contract NAG3-284) (AIAA PAPER 85-0466)

A brief review is given of four earlier tests in the NASA Lewis Icing Research Tunnel and of flight tests in NASA's Icing Research Aircraft and in a Cessna 206 airplane. Details are given of recent icing tunnel tests of thicker-skinned wings, a Gates Learjet, a composite leading edge, and a Boeing 767, and of a Falcon Fanjet engine inlet. These were tested at speeds from 87 to 220 knots, air temperatures from -2 to -15 C, LWC values of 0.6 to 2.4 grams/cu meter, and median droplet diameters from 12 to 20 microns. Energy requirements are reported, as well as conclusions from comparisons of several Electro-Impulse De-Icing coil system designs. Fundamental studies of the structural dynamics and ice shedding of a 12.7 cm (5 inch) diameter semicylinder are described. Some potential problem areas are discussed: fatigue of skin and coil mountings, system weight and cost, electro-magnetic interference and noise. Author

A85-21582#

JUDGMENT AND DISCIPLINE - RECIPE FOR SURVIVAL

J. R. GREENWOOD (Gates Learjet Corp., Tucson, AZ) IN: Symposium on Aviation Psychology, 2nd, Columbus, OH, April 25-28, 1983, Proceedings. Columbus, OH, Ohio State University, 1984, p. 393-400. refs

The major causes of aircraft accidents in the general aviation field are discussed in an anecdotal style, and with reference to National Traffic Safety Board (NTSB) statistics. It is shown that since 80 percent of the fatal aircraft accidents in the U.S. are caused by human factors, the exercise of better judgment and discipline on the part of professional pilots could reduce the number of fatalities significantly. It is recommended that future training courses for general aviation pilots place greater emphasis on developing judgment and discipline in the operation of commercial aircraft. I.H.

A85-21643

AN OVERVIEW OF HELICOPTER'S ENVIRONMENTAL CONSIDERATIONS

J. W. LEVERTON (Westland, Inc., Arlington, VA) Vertiflite (ISSN 0042-4455), vol. 31, Jan.-Feb. 1985, p. 14, 15.

Increasing helicopter rotor tip speeds for larger and heavier aircraft have tended to increase community awareness of noise levels, together with the dramatic increase in helicopter fleet size, over the last 10 years. The problems posed by this awareness are exacerbated by air traffic control practices which require flyover

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altitudes of 500 ft or less. As part of a general consideration of the helicopter noise problem, the FAA and ICAO have undertaken detailed evaluations of noise-related helicopter design factors. In addition, the American Helicopter Society, in conjunction with NASA and helicopter manufacturers, formulated the National Rotorcraft Noise Reduction Program. Recommendations have also been made for routine helicopter operations and heliport design criteria.

O.C.

A85-21668

STRESS ANALYSIS AND SHAPING OF THE CANOPY OF A SQUARE PARACHUTE [ANALIZ NAPRIAZHENNOGO SOSTOIANIYA I FORMOOBRAZOVANIYA KUPOLA KVADRATNOGO PARASHIUTA]

M. V. DZHALALOVA Moskovskii Universitet, Vestnik, Seriya 1 - Matematika, Mekhanika (ISSN 0579-9368), Nov.-Dec. 1984, p. 93-96. In Russian. refs

A calculation method is developed for determining the shape of the meridional cross sections and the equatorial stresses of the fabric of the canopy of a square parachute in the case when $\Delta p/q$ is a constant, where p is pressure and q is velocity head. It is assumed that there is a local similarity (i.e., a similarity of meridional cross sections) between the shapes of square and circular parachutes. The analysis is based on Rakhmatulin's equations for a circular parachute.

B.J.

N85-15700 Department of the Air Force, Washington, D.C.

WINDBLAST LEG PROTECTOR ASSEMBLY Patent

R. J. CUMMINGS, inventor (to Air Force) 14 Aug. 1984 8 p Supersedes AD-D010307

(AD-D011376; US-PATENT-4,465,250;

US-PATENT-APPL-SN-465230) Avail: US Patent and Trademark Office CSCL 06Q

This patent is for a windblast leg protector assembly for use by an occupant of an open-type ejection seat of an aircraft. The assembly includes, for each leg of the seat occupant, a modification to the occupant's conventional anti-acceleration suit by way of a piece of nylon fabric (with concave configured load spreading cuts, and with a ring captured thereon) attached to the thigh portion, and a similar piece of nylon fabric with a ring captured thereon attached to the calf portion, of each full length leg member of the anti-acceleration suit. Restraining-/retracting straps which are connected to, and which remain with the ejection seat, are also constituent components of the windblast leg protector assembly. Snap hooks, which are captured on the slack restraining/retracting straps, are releasably connected by the occupant, after sitting down in the ejection seat, to the captured rings on the thigh and the calf portions of the anti-acceleration suit being worn. During ejection, the slack restraining/retracting straps are automatically retracted and tensioned, thereby pulling downwardly on the captured rings, their retaining members, the leg members of the suit, and the legs of the occupant. As a result, the legs of the occupant are restrained, and thereby are prevented from being extended into the windblast. Although the thighs of the occupant are downwardly restrained during ejection, the calves of the seated occupant's legs move upwardly to relieve any tension load in the occupant's knees.

GRA

N85-15701*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

FLOW OF NITROGEN-PRESSURIZED HALON 1301 IN FIRE EXTINGUISHING SYSTEMS

D. G. ELLIOTT, P. W. GARRISON, G. A. KLEIN, K. M. MORAN, and M. P. ZYDOWICZ 1 Nov. 1984 124 p refs (Contract NAS7-918)

(NASA-CR-174271; JPL-PUBL-84-62; NAS 1.26:174271) Avail: NTIS HC A06/MF A01 CSCL 01C

Halon 1301 which is a halocarbon fire extinguishing agent (CBF₃) used by the U.S. Army for vehicle fire suppression is discussed. Halon 1301 is discharged under nitrogen pressure, and the Halon-nitrogen mixture is a two phase, two component mixture that obeys compressible fluid laws and exhibits choking effects. A computer model was developed to analyze the discharge of Halon

and nitrogen from a storage bottle through pipes and nozzles. The model agrees well with data from Halon 1301 discharge tests. The discharge time depends mainly on nozzle area and pipe volume, for given initial conditions. Graphs were developed for estimating discharge times. A nozzle employing multiple concentric converging/diverging nozzles was developed which gave hemispherical coverage.

E.A.K.

N85-15702*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

THE UH-1H HELICOPTER ICING FLIGHT TEST PROGRAM: AN OVERVIEW

R. J. SHAW and G. P. RICHTER 1985 26 p refs Presented at the 23rd Aerospace Sci. Meeting, Reno, Nevada, 14-17 Jan. 1985; sponsored by AIAA, 14-17 Jan. 1985

(NASA-TM-86925; E-2421; NAS 1.15:86925; AIAA-85-0338)

Avail: NTIS HC A03/MF A01 CSCL 01C

An ongoing joint NASA/Army program to study the effects of ice accretion on unprotected helicopter rotor aerodynamic performance is discussed. This program integrates flight testing, wind tunnel testing, and analytical modeling. Results are discussed for helicopter flight testing in the Canadian NRC hover spray rig facility to measure rotor aero performance degradation and document rotor ice accretion characteristics. The results of dry wind tunnel testing of airfoil sections with artificial ice accretions and predictions of rotor performance degradation using available rotor performance codes and the wind tunnel data are presented. An alternative approach to conducting future helicopter icing flight programs is discussed.

B.W.

N85-15703# Imperial Coll. of Science and Technology, London (England). Dept. of Aeronautics.

PROCEEDINGS OF THE INTERNATIONAL CONFERENCE AND EXPOSITION ON STRUCTURAL IMPACT AND CRASHWORTHINESS Final Report

G. A. O. DAVIES and J. MORTON 26 Oct. 1984 15 p Proc. held in London, 16-20 Jul. 1984 Sponsored in part by Army (Contract AF-AFOSR-0329-83)

(AD-A147845; EOARD-TR-85-03) Avail: NTIS HC A02/MF A01 CSCL 20K

This report summarizes the main keynote papers and conference papers for the International Conference on Structural Impact and Crashworthiness, held at Imperial College of Science & Technology, London, U.K. Attendees had different interests in high and low velocity impact, low velocity crashworthiness of aircraft, trains, ships and helicopters, and high speed ballistic perforation. Most of the papers concerned metal impact in which plasticity and gross deformations control the energy absorbing process. There was one day devoted to composites (mostly glass and carbon/graphite) where energy absorption is quite different. Several full-scale tests were reported and filmed, including two U.K. crash tests reported for the first time in public: a nuclear fuel cell impacted at 100 mph by a complete train, and a drop test with a Lynx Helicopter. The Pending Boeing 720 crash test was reviewed. The growing reliability of numerical programs for predicting crash response was evident, but there is still a long way to go before computational programs become a design tool. It was clear that both in Europe and the U.S.A. the reliable use of finite element/finite difference codes for simulating crash cases is an urgent need, with an experimental validation used once only.

GRA

N85-16840# Federal Aviation Administration, Atlantic City, N.J. PRELIMINARY EVALUATION OF AN IMPROVED FLAMMABILITY TEST METHOD FOR AIRCRAFT MATERIALS Final Report

C. P. SARKOS, R. A. FILIPCZAK, and A. ABRAMOWITZ Dec. 1984 48 p refs

(FAA-CT-84-22) Avail: NTIS HC A03/MF A01

Small-scale flammability test methods were evaluated by comparing data obtained on a series of interior honeycomb panels with fire test results obtained with a 1/4-scale cabin model. Generally, the vertical Bunsen burner, limiting oxygen index, and

radiant panel test methods ranked the phenolic-faced panels higher (better performance) than the epoxy-faced panels. It appears as if these test methods, which employ relatively moderate exposure conditions, are reflecting the superior ignition resistance of the phenolics over the epoxies. Thus, these tests cannot predict the performance of materials that exhibit high burning rates when subjected to heating conditions above their ignition threshold. The heating conditions used in the Ohio State University (OSU) apparatus, however, can be set at higher levels. At 5 watts/sq cm, rank ordering materials based on peak heat release rate measured via oxygen depletion in the OSU apparatus agreed with materials ranking in the 1/4-scale model. The OSU apparatus operated at these conditions and employing oxygen depletion calorimetry is the recommended improved fire test method for interior panels. Author

N85-16842# Naval Air Development Center, Warminster, Pa. Aircraft and Crew Systems Technology Directorate.

S-3A BALLAST BLOCK FINAL DESIGN AND ENGINEERING TESTS Final Report

D. LORCH and J. QUARTUCCIO 22 Feb. 1984 50 p
(AD-A147685; NADC-84015-60) Avail: NTIS HC A03/MF A01 CSCL 01C

The S-3A aircraft has four ejection seats. Both the pilot and copilot have command eject selector levers which allow them the option to eject all crewmembers or self eject. If one of the aft seats is unoccupied, and command eject is selected, the unoccupied seat will accelerate ahead of the occupied seat next to it. Two hazards exist: (1) the crewmember next to the unoccupied seat could be burned by the rocket plume from the empty seat which has a higher acceleration; (2) the empty seat could tumble into one of the other seats because the center of gravity and the center of rocket thrust are too far apart. To eliminate these hazards it is necessary to ballast the unoccupied seat. This is presently being done with anthropomorphic test dummies, if they can be obtained. Unfortunately these dummies have various weights and are usually damaged. There is no guarantee that the center of gravity is in the proper location to prevent tumbling. To correct this potentially dangerous situation the naval air systems command tasked the naval air development center to design a ballast block. After the initial prototype was developed and tested, references (1) and (2) recommended changes to be incorporated into the final design. All of these recommendations have been incorporated into the final design. The S-3A ballast block is a 169 pound assembly of four interlocking aluminum blocks. It is used to control the trajectory of an unoccupied 1E-1 ejection seat. Tests indicate that it meets all functional and structural requirements for use in the S-3A aircraft. GRA

N85-16844# Aerospace Medical Research Labs., Wright-Patterson AFB, Ohio. Biomedical Protection Branch.

IMPACT TESTS OF AUTOMATIC LAP BELT CONFIGURATIONS Final Report, 10 Oct. 1981 - Jul. 1984

J. W. BRINKLEY and D. E. SCHIMMEL 2 Jul. 1984 104 p
(Contract AF PROJ. 7231)
(AD-A148034; AFAMRL-TR-84-041) Avail: NTIS HC A06/MF A01 CSCL 06K

Sixteen impact tests of lap belt assemblies were performed to evaluate components for the HBU-X lap belt (now designated the HBU-12 lap belt). The lap belt assemblies were tested as part of a lap belt and shoulder harness configuration. Fifteen tests were conducted at a level of 40 G (mean = 40.2 G, S.D. = 0.898) with an average impact velocity of 105.7 ft/sec (S.D. 0.976). The impact vector was applied in the -G(sub x) direction. The primary purpose of the tests was to evaluate the effectiveness of two different types of webbing adjusters. The influence of nylon, polyester, and latex-impregnated polyester was also studied. The results of the impact tests and several modes of failure including belt slippage through the adjusters and fractures of the metal attachment link of the MB-6 shoulder harness are described. Revision of design and test conditions are recommended. GRA

N85-16845# Ketron, Inc., Warminster, Pa.

A GENERALIZED ESCAPE SYSTEM SIMULATION (GESS) COMPUTER PROGRAM. VOLUME 2: GESS PROGRAMMER'S MANUAL, VERSION 2 Final Report

L. A. DAULERIO (Naval Air Development Center, Warminster, Pa.) and D. A. FENDER Apr. 1984 349 p
(Contract N62269-81-C-0206; NR PROJ. 630-194)
(AD-A148363; NADC-84068-60) Avail: NTIS HC A15/MF A01 CSCL 09B

The Generalized Escape System Simulation (GESS) program is a computerized mathematical model for dynamically simulating the performance of existing or developmental aircraft ejection seat systems. The program generates six-dimensional trajectory predictions of the aircraft, seat/occupant, occupant alone, and seat alone by calculating the forces and moments imposed on these elements by the seat catapults, rails, rockets, stabilization, and recovery systems included in most escape systems configurations. User options are provided to simulate the performance of all conventional escape system designs under most environmental conditions and aircraft attitudes or trajectories. This Gess Programmer's Manual, summarizes program conventions, lists the annotated FORTRAN IV program code, and represents the second of two volumes of GESS documentation. GRA

N85-16846# Civil Aeronautics Board, Washington, D.C.

AIRPORT ACTIVITY STATISTICS OF CERTIFICATED ROUTE AIR CARRIERS Annual Report, period ending 31 Dec. 1983

31 Dec. 1983 365 p
(AD-A148472) Avail: NTIS HC A16/MF A01; also available
SOD HC \$14.00 CSCL 01E

This report furnishes airport activity of the Certificated Route Air Carriers. Included in the data contained in Table 6 are passenger enplanements, tons of enplaned freight, express, and mail. Both scheduled and non-scheduled service, and domestic and international operations are included. These data are shown by aircraft and carrier. Table 7 includes departures by airport, carrier and type of operation, and type of aircraft. Author (GRA)

N85-16847# Army Concepts Analysis Agency, Bethesda, Md.

UTILIZATION OF INCREASED AIRLIFT CAPABILITY (UIAC) STUDY Study Report, Apr. - Sep. 1984

J. A. SORENSON and J. DEPALMA Sep. 1984 272 p
(AD-A148669; CAA-SR-84-29) Avail: NTIS HC A12/MF A01 CSCL 15E

This study examined the increases in peacetime airlift capacity due to the Military Airlift Command's fleet expansion, determined the impacts on the Army transportation system and developed a process to select the most suitable cargo and route combinations to use the additional capacity. The results of analysis indicated that transportation cost avoidances could be realized by diverting surface port-packed cargoes to airlift; however by increasing airlift resupply, potential cost savings could increase. Author (GRA)

N85-16848# Bundesanstalt fuer Flugsicherung, Frankfurt am Main (West Germany). Buero des Nachrichten fuer Luftfahrer.

DIRECTIONS OF THE WEST GERMAN MINISTRY OF TRANSPORT FOR EDUCATION AND CONTROL OF AIRLINE PERSONNEL (SECTION 3, CHAPTERS 2 AND 12) [RICHTLINIEN DES BUNDESMINISTERS FUER VERKEHR FUER DIE AUSBILDUNG UND PRUEFUNG DES LUFTFAHRTPERSONALS, TEIL 2, KAPITEL 2 UND 12]

Mar. 1983 75 p In GERMAN
Avail: NTIS HC A04/MF A01

The education curriculum of second class pilots is described. It consists of a theoretical part and a practical part. The subjects are: air regulation and laws, air traffic and safety, navigation, weather forecasts, engineering, and reactions in special situations. Author (ESA)

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N85-16849# Bundesanstalt fuer Flugsicherung, Frankfurt am Main (West Germany). Buero der Nachrichten fuer Luftfahrer. DIRECTIONS OF THE WEST GERMAN MINISTRY OF TRANSPORT FOR EDUCATION AND CONTROL OF AIRLINE PERSONNEL, REPORT 6; CHAPTERS 3/A AND 3/B [VERKEHRSFLUGZEUGFUEHRER, DIE DIE ERLAUBNIS FUEHR BUNDESMINISTERS FUEHR VERKEHR FUEHR DIE AUSBILDUNG UND PRUEFUNG DES LUFTFAHRTPERSONALS, HEFT 6; KAPITEL 3A UND 3/B]

Apr. 1984 212 p. In GERMAN

Avail: NTIS HC A10/MF A01

The education curriculum of commercial aircraft captains is described. It consists of a theoretical part and a practical part. The subjects are: air regulations and laws, air traffic and safety, navigation, weather forecasts, engineering, and reactions in special situations. Author (ESA)

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AIRCRAFT COMMUNICATIONS AND NAVIGATION

Includes digital and voice communication with aircraft; air navigation systems (satellite and ground based); and air traffic control.

A85-19183

SPEECH RECOGNITION MAKING PROGRESS - DIRECT VOICE INPUT IS A PROMISING INFANT

C. BULLOCH Interavia (ISSN 0020-5168), vol. 39, Dec. 1984, p. 1319-1321.

The potentialities of existing Direct Voice Input (DVI) speech recognition equipment on the airliner flight deck is investigated. RAE trials, based on analysis of the Marconi SR-128 speech recognizer and made with a variety of microphones, indicate that boom-type microphones scored best, oxygen-mask mikes next, and throat microphones came third. One of the jobs for RAE's speech recognizer is to select COM/NAV radio frequencies, a job which requires recognition of connected rather than isolated words. Since the Marconi system is user-dependent, a scatter of error rates between different individual pilots is a result of the RAE trials. The US Air Force Advanced Fighter Technology Integration program is discussed and in it the DVI units are programmed to recognize only numbers after enunciation of a command keyword such as frequency. A speech or voice interaction system involving speech recognition and speech synthesis techniques, used for both DVI confirmation and for providing warnings is being employed in the next phase of the AFTI program. DVI is being investigated for possible uses involving human interfacing with computer-based systems, CAD/CAM, and word processing as some of the nearer-term objectives. M.D.

A85-19275

NEW GENERATION MILITARY TACTICAL AIRBORNE COMMUNICATIONS SYSTEMS - THE INTEROPERABILITY CHALLENGE

R. C. SMITH (Rockwell International Corp., Collins Avionics Div., Cedar Rapids, IA) Defense Systems Review and Military Communications, vol. 2, Nov. 1984, p. 56-60.

The modern air battlefield is populated by a sophisticated assortment of enemy electronic jammers, direction finders, decoys, and weapon systems dedicated to the disruption or exploitation of airborne communications. These systems are collectively of sufficient disruptive power to render the standoff range 'smart' weapons of the F-14 impotent, and further threaten the destruction of the F-14 itself by homing on its communications emissions. A revolutionary response to these enemy capabilities is the Joint Tactical Information Distribution System (JTIDS), which provides secure, antijam, high data throughput command and control communications. The Global Positioning System will furnish user-passive, high precision dimensional position and time readings

on a worldwide basis. TDMA and Distributed TDMA are both applicable to JTIDS. O.C.

A85-19620#

ATMOSPHERIC PROPAGATION LOSSES FOR LONG-RANGE AIRBORNE RADAR SYSTEMS ANALYSIS

C. J. PRUSZYNSKI (General Dynamics Corp., Fort Worth, TX) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 10 p. refs (AIAA PAPER 85-0267)

In determining the performance of very long range airborne radar systems, it is incumbent upon the radar systems analyst to take accurate account of atmospheric propagation losses. A simple model for predicting clear-air atmospheric attenuation in the microwave region (.1 to 35 GHz), based on the LOWTRAN atmospheric data base, is described and used to investigate the atmospheric propagation loss effects in several scenarios of interest. The results are then applied to the problem of selection of an optimal operating frequency for a hypothetical airborne radar system. Author

A85-19805

AVIATION RADAR [AVIATIONNAIA RADIOLOKATSIIA]

P. S. DAVYDOV, A. A. SOSNOVSKI, and I. A. KHAIMOVICH Moscow, Izdatel'stvo Transport, 1984, 224 p. In Russian. refs

This handbook presents information concerning the design and characteristics of radar systems in civil aviation. Typical components of radar systems are examined, including antennas, transmitters, receivers, and digital processing devices. Attention is given to the parameters of ATC scanning radars, landing-system radars, and various airborne radar systems (meteorological, Doppler, and transponder). Also considered are the operational characteristics of radar systems, methods of failure diagnostics, and the organization of technical-support systems. B.J.

A85-20221

MILITARY AVIONICS - INCREASING INTEGRATION AT ALL LEVELS

G. WARWICK Flight International (ISSN 0015-3710), vol. 126, Dec. 15, 1984, p. 1635-1638, 1640, 1641.

Attention is given to the design features, performance capabilities and operational consequences of state-of-the-art military avionics systems that are being incorporated into such aircraft as the F-15E dual role fighter, the Tornado F.2, and the A-10. Representative of integrated avionics are the F-15's Joint Tactical Information Distribution System, which is a jam-resistant, high capacity voice and data link, the Navstar Global Positioning System, which establishes user position to within 15 m in three dimensions and user velocity to within 0.1 m/sec, voice-control systems for fighter cockpits, ring laser gyro inertial reference systems, and wide angle holographic head-up displays, which can also function as night vision aids. O.C.

A85-21459#

HARDWARE DESIGN TECHNIQUES

A. BARLOW (Smith Industries, PLC, London, England) IN: Design and advanced concepts of avionics/weapons system integration; Proceedings of the Symposium, London, England, April 3, 4, 1984. London, Royal Aeronautical Society, 1984, 9 p.

The physical design of avionics hardware and installation structures for civil and military aircraft is discussed in a historical review of the UK and U.S. development since the 1940s. Consideration is given to vibration problems in aircraft with reciprocating engines and/or guns, the vibration sensitivity of tube and solid-state components, the various standardized connection and rack systems, thermal-management integration, and the potential EMI problems posed by the increasing use of composite materials in military-aircraft structures. Photographs, drawings, and diagrams of typical installations are shown. T.K.

A85-21461#

INTEGRATED NAVIGATION

R. N. PRIESTLEY (Ferranti, PLC, Cheadle, Ches., England) IN: Design and advanced concepts of avionics/weapons system integration; Proceedings of the Symposium, London, England, April 3, 4, 1984. London, Royal Aeronautical Society, 1984, 4 p. refs

The integration of avionics navigation subsystems is projected to enhance accuracy, as well as redundancy, fault tolerance, and data display efficiency. The testing and maintenance of an integrated system may be easier if full use is made of self-checking and self-calibration capabilities that inhere in such systems. In conditions where subsystem performance has decayed, however, great difficulties may arise in the isolation of the subsystem. Integration is noted to make possible modes of operation which would be impossible to implement through independent subsystems, as in the rapid, at-sea and in-air alignment of an inertial navigation system. O.C.

A85-21462#

INTEGRATED COMMUNICATIONS - A DESIGNERS VIEW

W. E. BRIERLEY (Marconi Avionics, Ltd., Airadio Products Div., Basildon, Essex, England) IN: Design and advanced concepts of avionics/weapons system integration; Proceedings of the Symposium, London, England, April 3, 4, 1984. London, Royal Aeronautical Society, 1984, 7 p.

An integrated aircraft communications system should ensure high confidence levels for all phases of a task or mission, allow effective operation at the lowest possible crew workload, and be cost-effective with respect to equipment size, weight, power demand, reliability and maintainability. It is noted that while the technology for control and display system integration is available, the techniques required in common communication signal processing remain to be developed. Attention is given to the unique integration problems encountered in the man/machine interface of control and display systems, the acquisition and/or transmission of communication intelligence, and signal processing. O.C.

A85-21838#

NONLINEAR SIMULATION OF FLIGHT ALONG WIND COMPENSATING CURVED GLIDEPATHS

A. B. MARKOV (Defence Research Establishment Suffield, Ralston, Alberta, Canada) and L. D. REID (Toronto, University, Toronto, Canada) Journal of Aircraft (ISSN 0021-8669), vol. 22, Feb. 1985, p. 97, 98. refs

A technique for defining curved glidepath geometries that compensate for some of the undesirable effects of low altitude winds is described. This technique uses an a priori estimate of the wind conditions present at the time of the landing approach to define a suitable glidepath geometry. The results of closed-loop, six degree-of-freedom simulation of a two-engined STOL transport conducting landing approaches on such curved approaches are summarized, and a number of recommendations for future work are made. Author

N85-15706*# Research Triangle Inst., Research Triangle Park, N.C. Center for Systems Engineering.

EFFECTS OF AIRCRAFT AND FLIGHT PARAMETERS ON ENERGY-EFFICIENT PROFILE DESCENTS IN TIME-BASED METERED TRAFFIC

F. R. DEJARNETTE Nov. 1984 19 p refs
(Contract NAS1-17023)

(NASA-CR-172338-ADD; NAS 1.26:172338-ADD; RTI/2467)
Avail: NTIS HC A02/MF A01 CSCL 17G

The influence of several parameters on the time required to fly a nominal profile descent of a B-737 from an entry fix to a metering fix 75 n.mi. away was studied. The ground distance for the constant speed segment was adjusted in each case so that the aircraft would always arrive at the metering fix position at the completion of the five segments of the profile descent. The influence of eight parameters on the same nominal profile descent is outlined, but the method used for the off nominal cases was changed. The time calculated for the constant speed segment in the nominal case is used for all off nominal cases. This method

allows the aircraft to arrive at the metering fix before or after the profile descent is complete. It is shown that descent Mach number and wind speed have a large effect on the time error, whereas weight was a much smaller effect. E.A.K.

N85-15707# Engineering and Economics Research, Inc., Vienna, Va.

NATIONAL AIRSPACE REVIEW: AIRPORT RADAR SERVICE AREA OPERATIONAL CONFIRMATION REPORT Final Report, Aug. 1983 - Oct. 1984

V. BHARTIYA, R. LEASURE, P. LU, M. J. ROLLS, and P. V. TAWARI Washington FAA Oct. 1984 201 p
(Contract DTFA01-82-Y-30562)
(DOT/FAA/AT-84/2; AD-A150008) Avail: NTIS HC A10/MF A01

The airport radar service area (ARSA), a new concept in terminal airspace design and services to standardize the designation of controlled airspace services, rules, and procedures within which terminal radar traffic control is provided was confirmed. The operational confirmation assessed the acceptability of the ARSA concept at two lead sites, Port Columbus International Airport, Columbus, Ohio, and Robert Muller Municipal Airport, Austin, Texas. The operational confirmation analysis of ARSA to determine its acceptance by users is presented. Data collection and analysis was geared towards two specific types: (1) opinion survey of local pilots, controller/staff, and supervisor/management at each of the facilities; and (2) lead site traffic activity profiles. It is concluded that ARSA is confirmed at Columbus, Ohio and Austin, Texas. E.A.K.

N85-15709# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Abt. Traegheitsortung und Navigation.

FLIGHT TESTING OF LITTON LASER GYRO STRAPDOWN SYSTEM LTN-90 FOR GENERAL AVIATION

H. J. HOTOP Jul. 1984 43 p refs In GERMAN; ENGLISH summary Translation is in process as (ESA-TT-904)
(DFVLR-MITT-84-16) Avail: NTIS HC A03/MF A01; DFVLR, Cologne DM 17

The instruments and data evaluation used for flight testing of two Litton laser gyro strapdown navigation systems in a DO-28 aircraft are described. The reference data based on the platform navigation system CAROUSEL 4a are corrected by application of optimal smoothing techniques. Results of the LTN-90 flight tests are presented and graphs of one of the flight tests are discussed. Author (ESA)

N85-16802# Department of National Defence, Ottawa (Ontario). DEVELOPMENT OF A HELICOPTER INTEGRATED NAVIGATION SYSTEM

D. F. LIANG, W. R. CLUBINE, L. C. VALLOT (Honeywell Systems and Research Center, Minneapolis, Minn.), and J. K. MAHESH (Honeywell Systems and Research Center, Minneapolis, Minn.) In AGARD Helicopter Guidance and Control Systems for Battlefield Support 19 p Aug. 1984 refs
Avail: NTIS HC A13/MF A01

The Canadian Department of National Defence has initiated a project to develop and test a helicopter integrated navigation system (HINS) that is capable of satisfying all the operational requirements of shipborne, antisubmarine warfare helicopters. The HINS mission requirements, development plan and its basic hardware and software configurations are discussed. The integrated system is expected to bring forth vital benefits in mission reliability, operational efficiency and navigation accuracy. Additional benefits are in terms of the size, weight, height and cost, etc. In the current phase of this work, extensive simulation software packages have been generated to accurately represent the operational characteristics of various off-the-shelf candidate subsystems. An Integrated System Evaluation Program has been developed which takes into account the various characteristics of the navigation subsystems and the mission requirements to systematically evaluate a sequence of candidate configurations. B.W.

04 AIRCRAFT COMMUNICATIONS AND NAVIGATION

N85-16804# Naval Air Development Center, Warminster, Pa.
STANDARD ATTITUDE HEADING REFERENCE SYSTEM (SAHRS) FULL SCALE DEVELOPMENT PROGRAM
K. L. BACHMAN /n AGARD Helicopter Guidance and Control Systems for Battlefield Support 12 p Aug. 1984 refs
Avail: NTIS HC A13/MF A01

There is a recognized need within the military services for reliable, low cost-of-ownership Attitude Heading Reference Systems (AHRS) capable of operating for extended periods without the need for calibration or regularly scheduled maintenance. In recognition of this need, the military services have embarked upon a joint service full scale engineering development program to provide a Standard Attitude Heading Reference System (SAHRS) utilizing strapdown technology for a multiplicity of rotary and fixed wing platforms. System design concepts, and performance characteristics are described. Procurement and schedules are also discussed. B.W.

N85-16851# Committee on Commerce, Science, and Transportation (U. S. Senate).

SATELLITE NAVIGATION

Washington GPO 1984 58 p Hearing on S. Con. Res. 69 before the Subcomm. on Aviation of the Comm. on Com., Sci. and Transportation, 98th Congr., 2d Sess., 23 May 1984 (S-HRG-98-856; GPO-35-977) Avail: Subcommittee on Aviation

Legislation is discussed which proposes making the civilian version of the global positioning system available to domestic airlines as well as to the commercial airlines of those countries which strictly abide by the spirit and letter of the International Air Services Transit Agreement. It is recommended that user fees not be imposed for either foreign or domestic users. The need for aircraft surveillance by satellite is examined as well as the inadequacy of current technologies. A.R.H.

N85-16852# Engineering and Economics Research, Inc., Falls Church, Va.

NATIONAL AIRSPACE REVIEW ENHANCEMENT PLAN, REVISION 3

19 Dec. 1984 64 p

Avail: NTIS HC A04/MF A01

The National Airspace Review (NAR) Plan was retitled as the National Airspace Review Enhancement (NARE) Plan to reflect the expanded scope of this undertaking. The airspace allocation, procedural, and regulatory aspects of improvements scheduled under the National Airspace System (NAS) plan and the shift of program sponsorship from the Associate Administrator for Air Traffic to the Director of Management Systems are reviewed. B.G.

N85-16853# Royal Signals and Radar Establishment, Malvern (England).

AIR TRAFFIC MANAGEMENT CONCEPTS FOR THE UK IN THE 1990'S: A REVIEW OF RECENT RSRE WORK

S. N. MAGILL and G. ORD Jun. 1984 26 p refs Presented at Eurocontrol Specialist Panel on Conflict Detection and Resolution (SPACDAR), Brussels, 21-23 Sep. 1983 Sponsored by Civil Aviation Authority

(AD-A147850; RSRE-MEMO-3714; BR93171) Avail: NTIS HC A03/MF A01 CSCL 17G

Air traffic management and control in the United Kingdom in the 1990's is discussed. Metering of arriving traffic and departure management and control are considered. Author (ESA)

N85-16855# Federal Aviation Agency, Atlantic City, N.J.

NATIONAL AIRSPACE REVIEW Interim Report

Jun. 1984 101 p

(AD-A147768) Avail: NTIS HC A06/MF A01 CSCL 17G

Since the summer of 1982, the Federal Aviation Administration (FAA) has been hosting task group working sessions of the National Airspace Review (NAR). The NAR is a cooperative venture by the aviation industry and government. The NAR is comprehensively reviewing current air traffic control procedures, flight regulations, and airspace for the purpose of validating the current system or identifying near-term changes which will promote greater efficiency.

As a component of the National Airspace System Plan, the NAR will provide the operational framework for moving into the next generation National Airspace System (NAS). In the area of procedures, task groups have covered: terminal services, weather programs, traffic flow management, helicopter operations, separation standards and the National Flight Data System. GRA

N85-16860# Institut fuer Rundfunktechnik, Munich (West Germany).

MEASUREMENT OF SIGNAL SEPARATION BETWEEN RADIO SERVICE AND AIR NAVIGATION SERVICE [SCHUTZABSTANDSMESSUNGEN ZWISCHEN RUNDFUNKDIENST UND FLUGNAVIGATIONSFUNK DIENST]

E. J. MIELKE 17 May 1982 21 p refs In GERMAN

(IRT-TB-B-40/82) Avail: NTIS HC A02/MF A01

Interference between the frequency range for the air navigation service (108 to 112 MHz) and the VHF-FM-radio range 8, which was recently extended to 108 MHz, was studied. Perturbation of the Instrument Landing System was considered. The signal separation was measured with an aircraft ILS receiver. The required signal separation is presented as a function of the frequency distances of disturbing radio stations. Author (ESA)

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AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

A85-19184

FROM AV-8B TO THE ASTOVL

B. SWEETMAN Interavia (ISSN 0020-5168), vol. 39, Dec. 1984, p. 1324-1327.

A runway-free future combat aircraft known as the ASTOVL (advanced short-take-off, vertical landing) and the AV-8B Harrier II which is, in operational terms, a stepping stone to ASTOVL are discussed. Although AV-8B meets its performance goals, it suffers from excessive drag at high speeds; without external stores, the AV-8B has a predicted maximum speed of 585 kn but the actual speed is in the region of 550-560 kn. The AV-8B program includes the development of a thermal imager and a multi-function display for a night-attack system which allows existing AV-8B to be used on clear nights and which is expected to increase production by 50 percent and of a radar system which requires a 10 percent thrust boost to 23,700 lbs. The AV-8 program points towards ASTOVL in two ways: through the development and use of the AV-8 across the entire spectrum of tactical roles and by generating a requirement for a new STOVL powerplant. US work on ASTOVL concepts is carried out by NASA-Ames. The program's objectives include improved stability augmentation and better flight guidance thus reducing excursions from the desired flightpath and the total reaction control system demand. M.D.

A85-19274

BOMB RACK TECHNOLOGY - KEEPING UP WITH ADVANCED WEAPONS

G. DE MOS (Western Gear Corp., Flight Structures Div., Lynwood, CA) Defense Systems Review and Military Communications, vol. 2, Nov. 1984, p. 40, 42-46.

The development and testing of a new advanced multiple stores ejection rack (MSER) are presented. MSER incorporates a dual dependent hydraulic ejection system, eliminating the effect of boundary layer reaction forces or of the store CG differentials, which is charged up from zero to 8000 psi in 70 milliseconds and ejects a 500 lb store at 20 ft/sec. A built-in-test capability provides a go/no go signal during the store loading operations and fault-isolates key circuits and a majority of the MSER components. The unit is adaptable to F-20, F-15, F-16, F-8, A-10, and AV-8B aircraft. The system is entirely modular, thereby cutting the

organizational maintenance time to under 10 min, and its ejector system requires no cleaning throughout its useful life. L.T.

A85-19457#

ATMOSPHERIC ELECTRICITY HAZARDS TO AIRCRAFT OPERATION

R. C. PEAVIN, J. R. LIPPERT, and J. E. LAVOIE (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 12 p. (AIAA PAPER 85-0013)

An advanced program for the development of effective atmospheric electricity hazards protection (AEHP) for military/transport aircraft is presented. The lightning threat parameters are defined for moderate and severe flashes (200 kA peak and 200 kA/microsecond rise rate), with particular attention to aircraft using large areas of composite materials. Protection concepts considered include circuit/system shielding, terminal protection, conducting floors, and cable protection. The demonstration testing will use modified F-14 fighter and YUH-61 helicopter airframes, with selected replacement of metal skin areas with composite and dielectric materials, together with test electronics consisting of digital processors and fiber-optics communication links, and is scheduled for May 1986. L.T.

A85-19459#

THE FEDERAL AVIATION ADMINISTRATION'S ENGINEERING AND DEVELOPMENT AIRCRAFT ICING PROGRAM

C. O. MASTERS (FAA, Technical Center, Atlantic City, NJ) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 9 p. refs (AIAA PAPER 85-0015)

The goals and current status of the FAA Engineering and Development Aircraft Icing Program are described. Consideration is given to the identification of meteorological icing characteristics which can be used to determine flight risks for commercial fixed wing aircraft and helicopters. The development of ground deicing systems to permit certification for aircraft operating under icing conditions is also discussed. The use of computer simulations of the icing environment for certification tests is reviewed. A block diagram is provided which illustrates the organization of current FAA deicing E and D programs. I.H.

A85-19584#

MAXIMUM FINAL ENERGY CHANDELLE

I. MANSOUR (Purdue University, West Lafayette, IN; Military Technical College, Cairo, Egypt) and D. ANDRISANI, II (Purdue University, West Lafayette, IN) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 7 p. refs (AIAA PAPER 85-0200)

Classical solution of the chandelle assumes exchange of kinetic and potential energies. The objective of this paper is to find an optimal load factor and bank angle control law such that the total energy of the airplane is maximized at the end of the maneuver. The maximum principle is used to find the necessary conditions of optimality. Then an ordinary gradient algorithm is used to solve this trajectory optimization problem. The obtained optimal control law is practical in the sense that it is easy for a pilot to perform. The gain in the final total energy is highly remarkable compared to the classical solution of the chandelle. The paper illustrates that the gradient algorithm is very efficient in this highly nonlinear trajectory optimization problem. Author

A85-19619#

THE AERODYNAMIC EFFECT OF SURFACE WETTING CHARACTERISTICS ON A LAMINAR FLOW AIRFOIL IN SIMULATED HEAVY RAIN

R. J. HANSMAN, JR. and M. F. BARSOTTI (MIT, Cambridge, MA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 8 p. refs (AIAA PAPER 85-0260)

Wind tunnel experiments have been conducted on a natural laminar flow airfoil in a simulated heavy rain of 440 mm/hr at a Reynolds number of 310,000 to assess the effect of surface wettability on the performance degradation due to rain. A significant loss of performance was observed for each of the three surfaces tested with the nonwetttable, waxed, surface being the most degraded (75 percent reduction in maximum L/D) and the incompletely wetttable epoxy gel coat being the least (45 percent reduction). Accompanying the L/D loss was an effective reduction in angle of attack of up to 2 deg resulting from a downward translation of the C(L) polar. In photographic observations, the runback water layer was found to bead on the wax surface and to sheet on the wetttable surfaces. The strong dependence on surface wettability of both the airfoil performance and the water behavior indicates that the degradation due to heavy rain is primarily a result of the roughening of the airfoil surface by the runback water layer. The observed performance loss could only be partially emulated by causing premature transition from a laminar to turbulent boundary layer. Author

A85-19623#

INEXPENSIVE CALIBRATIONS FOR THE INFLUENCE FUNCTION METHOD USING THE INTERFERENCE DISTRIBUTED LOADS CODE

K. S. KEEN (Calspan Field Service, Inc., Arnold Air Force Station, TN) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 5 p. USAF-supported research. refs (AIAA PAPER 85-0270)

Two engineering prediction methods for the calculation of store aerodynamic loads within the interference flow field of an aircraft have been integrated to produce a tool with capabilities beyond the range of either method individually. A reduction in computer cost of three-orders-of-magnitude has been realized in the theoretical determination of the influence response coefficient distributions of conventional store configurations. Additionally, nonlinear aerodynamic effects such as vortex downwash on the store afterbody were modeled. The integrated method has been incorporated into an interactive geometry modeling/input preparation system which allows a user with little or no familiarity with the related codes to derive the influence coefficient distributions with minimal effort. Predictions of store loads in an aircraft flow field using these influence coefficients have shown very good agreement with experimental data. Author

A85-19626*#

THE JOINED WING - AN OVERVIEW

J. WOLKOVITCH (ACA Industries, Inc., Torrance, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 27 p. refs (Contract NAS2-11255; NAS2-11725; N00014-79-C-0953; N00014-82-C-0607) (AIAA PAPER 85-0274)

The joined wing is a new type of aircraft configuration which employs tandem wings arranged to form diamond shapes in plan view and front view. Wind-tunnel tests and finite-element structural analyses have shown that the joined wing provides the following advantages over a comparable wing-plus-tail system; lighter weight and higher stiffness, higher span-efficiency factor, higher trimmed maximum lift coefficient, lower wave drag, plus built-in direct lift and direct sideforce control capability. A summary is given of research performed on the joined wing. Calculated joined wing weights are correlated with geometric parameters to provide simple weight estimation methods. The results of low-speed and transonic wind-tunnel tests are summarized, and guidelines for design of

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joined-wing aircraft are given. Some example joined-wing designs are presented and related configurations having connected wings are reviewed. Author

A85-19627# **THE DESIGN AND TESTING OF SEVERAL JOINED WING RPV'S**

J. N. PERKINS (North Carolina State University, Raleigh, NC), F. M. CHEATWOOD, R. J. VESS, and R. A. WAHLS American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 9 p.

(AIAA PAPER 85-0275)

Attention is given to the design features and test performance results of five tip-joined wing configuration models which were subjected to wind tunnel and flight tests. The test results indicate that it is not possible to obtain all advantages claimed for joined wing configurations simultaneously. It is noted, on the basis of these results, that any future joined wing design should locate its ailerons outboard of the wingtip joining point, and that flaps should be located on the rear wing. The elevators would then be on the front wing, so that trimming movement yields increased lift for both wings. Canards should not be used for trimming purposes. It is important that there be no significant spanwise flow over the front wing. O.C.

A85-19677*# National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.

GROUND-EFFECT ANALYSIS OF A JET TRANSPORT AIRPLANE

R. E. CURRY and A. H. BOWERS (NASA, Flight Research Center, Edwards, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 10 p. refs

(AIAA PAPER 85-0307)

An analysis of the ground effect of a jet transport airplane has been made. Data were obtained from recent flight tests primarily using the constant angle-of-attack approach technique. Reasonable results were obtained for ground-effect pitching moment and lift increments. These were compared with data from other sources, including computations, wind tunnel, and previous flight tests. A recommended ground-effect model was developed from the results. A brief simulator study was conducted to determine the sensitivity of a particular configuration to this ground-effect model and its associated uncertainty. Author

A85-19684# **AERODYNAMIC CONFIGURED MISSILES - PROMISE AND FUTURE**

R. J. KRIEGER (McDonnell Douglas Astronautics Co., St. Louis, MO) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 11 p. refs

(AIAA PAPER 85-0345)

The results of both the Air Force sponsored Aerodynamic Configured Missile (ACM) program, with the objective of exploiting the aerodynamic potential of supersonic cruise and maneuvering missiles, and the subsequent Low Cost Aerodynamic Configured Missile Demonstrator Program are summarized with emphasis on the impact of these studies on future missile concepts. The major uses of the programs, such as the points of departure concepts, direct prediction of aerodynamics, and evaluation of prediction techniques are discussed with regard to the use of the experimental data base. The Panair computer methods can be applied for Mach numbers up to 5. Wind tunnel testing showed significantly higher L/D ratios than for conventional circular missiles. Flight demonstrations are planned with a flight-proven ARIES solid fuel booster, including the ground launch scenario and the B52/ARIES scenario. L.T.

A85-19734*# Toledo Univ., Ohio.

FULL TWO-DIMENSIONAL TRANSIENT SOLUTIONS OF ELECTROTHERMAL AIRCRAFT BLADE DEICING

K. C. MASIULANIEC, T. G. KEITH, JR., K. J. DEWITT, and K. L. LEFFEL (Toledo, University, Toledo, OH) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 9 p. NASA-supported research. refs

(AIAA PAPER 85-0413)

Two finite difference methods are presented for the analysis of transient, two-dimensional responses of an electrothermal de-icer pad of an aircraft wing or blade with attached variable ice layer thickness. Both models employ a Crank-Nicholson iterative scheme, and use an enthalpy formulation to handle the phase change in the ice layer. The first technique makes use of a 'staircase' approach, fitting the irregular ice boundary with square computational cells. The second technique uses a body fitted coordinate transform, and maps the exact shape of the irregular boundary into a rectangular body, with uniformly square computational cells. The numerical solution takes place in the transformed plane. Initial results accounting for variable ice layer thickness are presented. Details of planned de-icing tests at NASA-Lewis, which will provide empirical verification for the above two methods, are also presented. Author

A85-19739*# General Dynamics Corp., San Diego, Calif.

NUMERICAL OPTIMIZATION DESIGN OF ADVANCED TRANSONIC WING CONFIGURATIONS

G. B. COSENTINO (General Dynamics Corp., Convair Div., San Diego, CA; Colorado, University, Boulder, CO) and T. L. HOLST (NASA, Ames Research Center, Applied Computational Aerodynamics Branch, Moffett Field, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 15 p. Previously announced in STAR as N84-27718. refs

(AIAA PAPER 85-0424)

A computationally efficient and versatile technique for use in the design of advanced transonic wing configurations has been developed. A reliable and fast transonic wing flow-field analysis program, TWING, has been coupled with a modified quasi-Newton method, unconstrained optimization algorithm, QNMDIF, to create a new design tool. Fully three-dimensional wing designs utilizing both specified wing pressure distributions and drag-to-lift ratio minimization as design objectives are demonstrated. Because of the high computational efficiency of each of the components of the design code, in particular the vectorization of TWING and the high speed of the Cray X-MP vector computer, the computer time required for a typical wing design is reduced by approximately an order of magnitude over previous methods. In the results presented here, this computed wave drag has been used as the quantity to be optimized (minimized) with great success, yielding wing designs with nearly shock-free (zero wave drag) pressure distributions and very reasonable wing section shapes. B.W.

A85-19741*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

POTENTIAL FLOW CALCULATIONS AND PRELIMINARY WING DESIGN IN SUPPORT OF AN NLF VARIABLE SWEEP TRANSITION FLIGHT EXPERIMENT

E. G. WAGGONER, P. S. PHILLIPS (NASA, Langley Research Center, Hampton, VA), J. K. VIKEN (Mandex, Inc., Falls Church, VA), and W. H. DAVIS (Grumman Aerospace Corp., Bethpage, NY) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 13 p. refs

(AIAA PAPER 85-0426)

NASA Langley and NASA Ames-Dryden have defined a variable-sweep transition-flight experiment utilizing the F-14 aircraft to enhance understanding of the interaction of crossflow and Tollmien-Schlichting instabilities on a laminar-boundary-layer transition. The F-14 wing outer panel will be modified to generate favorable pressure gradients on the upper wing surface over a wide range of flight conditions. Extensive computations have been

performed using two-dimensional and three-dimensional transonic analysis codes. Flight-test and computational data are compared and shown to validate the applicability of the three-dimensional codes (WBPPW and TAWFIVE). In addition, results from two preliminary glove designs derived from two different approaches to the design problem are presented. Advantages and disadvantages of each approach are identified, and it is concluded that coupling an analysis code with an automated design procedure yields a powerful code with distinct advantages over a 'cut-and-dry' approach. Author

A85-19758*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
ARRAYS FOR MINIMUM WAVE DRAG OF BODIES OF REVOLUTION

J. N. NIELSEN (NASA, Ames Research Center, Moffett Field, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 13 p. (AIAA PAPER 85-0449)

The wave drag of two identical Sears-Haack bodies at transonic and supersonic speeds has been determined by using the supersonic area rule. The solution is found for these bodies displaced parallel to each other, both laterally and longitudinally. The results show that the drag of a pair of bodies can be either doubled, or nearly halved, depending upon the lateral and longitudinal spacings of the bodies. The magnitude of this drag is determined by the degree of mutual interference between the bodies. It is shown how reductions in wave drag can be obtained by proper spacing of external bodies. The regions of favorable mutual interference are delineated. It is also shown how to apply the two-body results to many-body arrays. Some remarks are made on applying the results to store-airframe interference and on further aspects of the store-airframe drag problem. Author

A85-19789# INFLUENCE OF PROPULSION/MISSION PROFILE COMBINATIONS UPON GENERIC MISSILE PENETRATION OF A HYPOTHETICAL DEFENSE

M. M. BRIGGS and V. H. L. CHENG (Integrated Systems, Inc., Palo Alto, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 12 p. refs (AIAA PAPER 85-0495)

In the present standoff range guided missile design tradeoff study, the ability to penetrate enemy defenses is introduced as a measure-of-merit in the selection of missile airbreathing propulsion schemes. These propulsion schemes are associated with sets of mission profiles compatible with payload requirements and gross weight constraints, so that a unique mission profile may be identified which uses all available propellant in reaching the target while undertaking minimum exposure to enemy defenses. The three propulsion system types considered were an air-turboramjet, an integral rocket/ramjet, and an unaugmented turbojet. Simulations of the penetration mission were conducted in Monte Carlo fashion to determine average survival probabilities for the missiles. The air-turboramjet propulsion scheme yielded the highest survival rate, due to its high speed and cruise altitude. O.C.

A85-19790# INTERACTIVE DESIGN TECHNIQUE FOR ARBITRARY SHAPED, AIRBREATHING MISSILE CONFIGURATIONS

R. J. KRIEGER (McDonnell Douglas Astronautics Co., St. Louis, MO) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 11 p. (AIAA PAPER 85-0496)

A computer-aided design procedure is described for use in conceptual design for sizing and shaping supersonic non-circular missiles with turbojet or ramjet propulsion systems. The theoretical basis for the method which uses a sensitivity derivative approach is developed. Avionics, structures, payload, inlet, engine, fuel, aerodynamic and performance models are described. Inlet/engine sizing, external moldline shaping and interactive graphics design

processes are presented. The synthesis procedure overcomes many of the major drawbacks of airbreathing missile synthesis. It has features such as: simple initial geometry setup for body, wings, tails and inlets; modeling of completely arbitrary missile shapes; non-circular subsystem packaging; non-circular and multiple inlet modeling; aerodynamic and performance shaping; low cost, short duration computer sessions; rapid convergence; and accurate aerodynamic predictions. Two example configuration shapings are provided to depict the sizing process. Author

A85-19836 EXPERIMENTAL METHODS FOR WIND-TUNNEL FLIGHT-MECHANICS INVESTIGATIONS USING DYNAMICALLY SIMILAR AIRCRAFT MODELS [BEITRAEGE ZUR VERSUCHSMETHODIK FUER FLUGMECHANISCHE UNTERSUCHUNGEN MIT DYNAMISCH AEHNLICHEN FLUGZEUGMODELLEN IM WINDKANAL]

H. SUBKE Braunschweig, Technische Universitaet, Fakultae fuer Maschinenbau und Elektrotechnik, Dr.-Ing. Dissertation, 1984, 144 p. In German. refs

The aerodynamic response of a lightweight advanced-technology-wing aircraft based on the Do-28 is investigated using a computer simulation and a fixed dynamically scaled CFRP 1:8 wind-tunnel model with active control surfaces. The principles of wind-tunnel simulation are reviewed; the governing equations of a fixed model are derived; a model is constructed; and preliminary tests of the responses to elevator activation and to gusts are performed. The results are presented in graphs and tables and used to develop corrections to the dynamic derivatives of the model equations and to implement active-control systems which modify the natural dynamics of the wind-tunnel model to account for different profiles and mission requirements. Good agreement between computer and wind-tunnel results is obtained when the corrected control systems are employed. T.K.

A85-20058 TECHNOLOGY GAINS EXPECTED TO YIELD LHX SIZE, WEIGHT, COST REDUCTIONS

Aviation Week and Space Technology (ISSN 0005-2175), vol. 122, Jan. 14, 1985, p. 47, 49, 51, 55-57.

It is noted that technological advances in rotor design, composite structures, flight control systems, and cockpit automation, as well as their integration in helicopter configurations, suggest significant reductions in the size, weight, and life cycle costs of the U.S. Army's prospective family of light scout/utility/attack helicopters, designated 'LHX'. The emerging battlefield threats to be met by such rotorcraft have led to the stipulation of single pilot operation, and significant enhancement of survivability through radar, IR, visual and acoustic signature reductions. Ballistic and nuclear/biological/chemical warfare protection are also central to LHX specifications. Standoff range and multitarget engagement capabilities, and air-to-air defense systems, are to be incorporated. Attention is presently given to the development status of LHX flight controls, navigation aids, communications, cockpit displays, sensors, and weapons. O.C.

A85-20059 STRUCTURAL COMPONENTS, DESIGN OF TILT-ROTOR JVX NEAR COMPLETION

Aviation Week and Space Technology (ISSN 0005-2175), vol. 122, Jan. 14, 1985, p. 84-87.

The joint services vertical lift aircraft, designated 'JVX', is a twin-engine tilt-rotor vehicle that is expected to replace most of the existing medium lift helicopter fleet of U.S. military services during the 1990s. JVX will have a dash speed of 275 kt and a tactical range of 1400 nautical miles. These performance capabilities meet a variety of applications, such as combat assault for the Marine Corps, combat search and rescue for the Navy, and ground support activities for the Army. Attention is presently given to JVX nacelle and rotor tests, technological risk management, and the results of a weight management program. O.C.

A85-20142 AEROELASTIC CHARACTERISTICS OF THE AH-64 BEARINGLESS TAIL ROTOR

D. BANERJEE (Hughes Helicopters, Inc., Culver City, CA) (Integrated Technology Rotor Methodology Workshop, Moffett Field, CA, June 20, 21, 1983) Vertica (ISSN 0360-5450), vol. 8, no. 3, 1984, p. 263-287. refs

The results of a wind tunnel test program to determine the performance loads and dynamic characteristics of the Composite Flexbeam Tail Rotor (CFTR) for the AH-64 Advanced Attack Helicopter are reported. The CFTR uses an elastomeric shear attachment of the flexbeam to the hub to provide soft-inplane S-mode and stiff-inplane C-mode configuration. The properties of the elastomer were selected for proper frequency placement and scale damping of the inplane S-mode. Kinematic pitch-lag coupling was introduced to provide the first cyclic inplane C-mode damping at high collective pitch. The CFTR was tested in a wind tunnel over the full sideslip envelope of the AH-64. It is found that the rotor was aeroelastically stable throughout the complete collective pitch range and up to rotor speeds of 1403 rpm. The dynamic characteristics of the rotor were found to be satisfactory at all pitch angles and rotor speeds of the tunnel tests. The unique design characteristics of the rotor which permit the high performance characteristics are discussed. Several schematic drawings and photographs of the rotor are provided. I.H.

A85-20146 FORWARD SWEEP - THE PROS AND CONS

B. R. A. BURNS (British Aerospace, PLC, Preston, Lancs., England) Interavia (ISSN 0020-5168), vol. 40, Jan. 1985, p. 39-41.

The swept-forward wing (SFW) design is analyzed as applied to modern fighter requirements, with reference to the X-29A experimental fighter. Due to lower sweep at all points forward of 70 percent chord the SFW has lower induced drag, higher lift slope, reduced pitch-up tendency, and smaller structural span, leading to reduced weight compared with equivalent SBW. An increased wave drag in the supersonic flight and more severe bending loads due to off-loading of the tips for a partially-stalled wing are noted. Maximum lift/drag ratios of the SFW and SBW are compared diagrammatically for Mach numbers up to 1.6; the SFW is superior up to speeds of approximately 0.9 Mach. The comparison of fuel requirement in different missions shows a 10-percent benefit for the SFW for battlefield air-cover mission, and a 5-percent penalty for point intercept mission as compared to the SBW. L.T.

A85-20147 MI-28 - THE SOVIETS CREATE HAVOC

M. LAMBERT Interavia (ISSN 0020-5168), vol. 40, Jan. 1985, p. 44, 45.

A possible description of the Soviet Mi-28 Havoc antitank helicopter is given, and a comparison is made with the AH-64 Apache. The following estimates are given, with the corresponding AH-64 parameters in parentheses: fuel consumption of no less than 1200 lb/h (900 lb/h); two engines with take-off power of at least 1340 SHP (1688 SHP) each; combat weight 15,652 lbs (14,694 lbs) and empty weight 10,360 lbs (11,015 lbs); and hover ceiling 12,000 ft (13,400 ft). The five-blade rotor, noted to improve the helicopter's low-speed performance, is of almost identical diameter as that of the AH-64, and is suggested to be an adaptation of the Mi-8 Hip rotor. The Mi-28 has direct optics, a nose-mounted 34 to 40 GHz pulse radar, and a supporting FLIR. It is armed with a millimetric-radar homing version of the AT-6 Spiral as antitank armament, a podded version of the SA-14 for air-to-air fighting, and a turret-mounted 23 mm gun. The paper concludes that the Mi-28 does not represent a significant advance on technology being used in the West, and that the Soviet Air Force appears to be adopting Western methods in antiarmor helicopters. L.T.

A85-20222 BOEING'S REJUVENATED TWIN JET

H. HOPKINS Flight International (ISSN 0015-3710), vol. 126, Dec. 29, 1984, p. 1708-1711.

The 737-300 variant of the 737 twin-engine airliner has been fitted with a 104-in fuselage stretch and 20,000-lb thrust CFM56-3B1 engines, which offer lower operating noise levels and fuel consumption. Hydraulic systems have also been substantially revised to yield greater capacity and flexibility. Attention is presently given to the flight handling characteristics of the 737-300, whose roll and yaw trim are electrically adjusted. The wing leading edge of this variant has been modified to achieve reduced cruise drag, and advanced avionics are incorporated. O.C.

A85-20469 LOADING CHARACTERISTICS OF VTOL AIRCRAFT AND THEIR EFFECT ON THE REMAINING LIFE OF THE AIRCRAFT [OSOBNOSTI NAGRUZHENIIA SAMOLETA VERTIKAL'NOGO VZLETA I POSADKI I IKH VLIYANIE NA RASKHODOVANIE PROCHNOSTNOGO RESURSA]

V. V. NOVITSKII and V. F. PAVLENKO IN: Current problems in aviation science and technology. Moscow, Izdatel'stvo Mashinostroenie, 1984, p. 164-172. In Russian. refs

The contributions of various types of loading to the diminution of the remaining life of VTOL aircraft are estimated. Particular attention is given to acoustic loading, vibrations, and pressure fluctuation in turbulent flow. As an example, a solution is presented to the problem of determining the life of a panel exposed to turbulent flow. V.L.

A85-20473 A FORMALISM FOR THE DESIGN PROBLEM OF AIRCRAFT SYSTEM UNIVERSALIZATION [FORMALIZATSIYA PROEKTNOI ZADACHI UNIVERSALIZATSII LETATEL'NYKH APPARATOV AVIATIONNOI SISTEMY]

E. V. TARASOV and S. A. USTINOV IN: Current problems in aviation science and technology. Moscow, Izdatel'stvo Mashinostroenie, 1984, p. 198-205. In Russian.

Various formulations of design problems based on a variety of universalization techniques are examined. A mathematical model for aircraft systems allowing for universalization on the basis of the building-block approach is proposed. A solution is presented to the problem of finding an optimal configuration for a hypothetical system of modular aircraft using basic modules of specified configurations. V.L.

A85-20875# STOL TECHNOLOGY FOR CONVENTIONAL FLIGHT ENHANCEMENT

J. P. LANDFIELD (Grumman Aerospace Corp., Bethpage, NY) and C. HENDERSON (U.S. Naval Air Development Center, Warminster, PA) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct. 31-Nov. 2, 1984. 12 p. refs

(Contract N62269-83-C-0227)
(AIAA PAPER 84-2397)

Previous limited-scope investigations have identified promising extensions of STOL technologies into conventional flight regimes. A study was conducted to examine the design requirements and performance impact of integrating various aero/propulsive techniques into an advanced, supersonic carrier based tactical aircraft. Comparisons of takeoff, landing, combat maneuvering, and subsonic cruise characteristics were made with a CTOL baseline aircraft. A mission sizing evaluation was performed to quantify the iterative effects of installing a selected powered-lift technology suite. These investigations reaffirm that STOL capability adds weight and complexity to a high performance CTOL aircraft. However, the careful integration of powered lift technology compensated for the historical STOL penalty by offering unique operational and tactical advantages. Author

A85-21378

K747 COMPOSITE MAIN ROTOR BLADE MODIFICATION, ANALYSIS AND QUALIFICATION FOR NEW HIGH TEMPERATURE REQUIREMENTS

C. T. GUNSALLUS and M. A. BOWES (Kaman Aerospace Corp., Bloomfield, CT) IN: Composite structures; Proceedings of the National Specialists' Meeting, Philadelphia, PA, March 23-25, 1983. Washington, DC, American Helicopter Society, 1984, 9 p.

The K747 Composite Main Rotor Blade used on the Army AH-1S helicopter has undergone some redesign and analysis and has been qualified for use under extreme conditions of combined solar radiation and high ambient temperature. This environment has been shown to result in static blade material temperatures, approaching 220 F for black painted blades, well in excess of the previously accepted and specified extreme of 160 F. This problem was first recognized as a result of an in-service blade failure, which involved separation of the brass tip ballast weight from the blade during ground operation. This failure, which occurred in the desert in mid-summer, was duplicated through high temperature ground-air-ground fatigue testing which revealed that the original tip ballast weight retention design was not suitable for temperatures significantly above 160 F. Author

A85-21379

DESIGN, FABRICATION AND VERIFICATION OF COMPOSITE FLEXBEAM TAIL ROTOR FOR AH-64 APACHE HELICOPTER

S. TAHA (Hughes Helicopters, Inc., Culver City, CA) and S. WIESENBERG (U.S. Army, Aviation Research and Development Command, St. Louis, MO) IN: Composite structures; Proceedings of the National Specialists' Meeting, Philadelphia, PA, March 23-25, 1983. Washington, DC, American Helicopter Society, 1984, 9 p.

A composite flexbeam tail rotor for the AH-64 Apache has been designed, fabricated and successfully subjected to structural and wind tunnel tests. The composite flexbeam tail rotor (CFTR) concept presented herein eliminates the use of pitch bearing, mechanical fastening and reduces the requirements for highly loaded structural joints. This has been accomplished by use of tailored, directed fiber structural flexbeams and efficient bonding of pitch control component to the blade assembly. Dynamically, the CFTR concept is soft in-plane for reactionless and collective boundary conditions and stiff in-plane for the cyclic case. Author

A85-21381

SIKORSKY COMPOSITE ROTOR HUB DEVELOPMENT

P. OGLE and G. WEHNERT (United Technologies Corp., Sikorsky Aircraft Div., Stratford, CT) IN: Composite structures; Proceedings of the National Specialists' Meeting, Philadelphia, PA, March 23-25, 1983. Washington, DC, American Helicopter Society, 1984, 8 p.

While the current production S-76 and Black Hawk helicopter main rotor hubs are combined aluminum and titanium structures with two elastomeric bearings per blade, a combined glass fiber/graphite-reinforced structure is under development which will be interchangeable with existing hubs. The concept of this damage tolerant/safe life rotor hub combines an isotropic material with unidirectional glass fiber to yield a redundant structure with essentially infinite life, and very high resistance to cross structure cracking. O.C.

A85-21383* National Aeronautics and Space Administration, Langley Research Center, Hampton, Va.

GROUND TEST EXPERIENCE WITH LARGE COMPOSITE STRUCTURES FOR COMMERCIAL TRANSPORTS

H. L. BOHON, A. J. CHAPMAN, III, and H. A. LEYBOLD (NASA, Langley Research Center, Hampton, VA) IN: Composite structures; Proceedings of the National Specialists' Meeting, Philadelphia, PA, March 23-25, 1983. Washington, DC, American Helicopter Society, 1984, 20 p. Previously announced in STAR as N83-29732. refs

The initial ground test of each component resulted in structural failure at less than ultimate design loads. While such failures represent major program delays, the investigation and analysis of each failure revealed significant lessons for effective utilization of composites in primary structure. Foremost among these are secondary loads that produce through-the-thickness forces which

may lead to serious weaknesses in an otherwise sound structural design. The sources, magnitude, and effects of secondary loads need to be thoroughly understood and accounted for by the designers of composite primary aircraft structures. Author

A85-21384

STRUCTURAL ANALYSIS AND TESTING OF ACAP SUBCOMPONENTS

H. GAEBE and H. KEARNEY (United Technologies Corp., Sikorsky Aircraft Div., Stratford, CT) IN: Composite structures; Proceedings of the National Specialists' Meeting, Philadelphia, PA, March 23-25, 1983. Washington, DC, American Helicopter Society, 1984, 14 p.

The Advanced Composite Airframe Program (ACAP) is a proprietary effort to demonstrate successful applications of such materials and their structural design concepts in airframe primary structures and landing gear. Attention is given to the results obtained to date by analyses and tests for ACAP structural subcomponents that include the windshield center post pultrusion, the empennage structure, and the cabin roof structure of the test helicopter. O.C.

A85-21386

CRASHWORTHINESS OF HELICOPTER COMPOSITE STRUCTURES

J. D. CRONKHITE (Bell Helicopter Textron, Fort Worth, TX) and L. T. BURROWS (U.S. Army, Applied Technology Laboratory, Fort Eustis, VA) IN: Composite structures; Proceedings of the National Specialists' Meeting, Philadelphia, PA, March 23-25, 1983. Washington, DC, American Helicopter Society, 1984, 16 p. refs

Two full scale composite-structure helicopter cabin sections derived from a preliminary design for the U.S. Army's Advanced Composite Airframe Program were subjected to crash testing which simulated zero- and 20-deg roll impact attitudes at a vertical impact velocity of 30 ft/sec. Test results indicate that structural deformation was restricted to areas designed to crush and absorb energy. In addition, two computer crash simulation programs for use in the design of crashworthy structures, designated KRASH and DYCAST, have been developed. O.C.

A85-21387

ADVANCED COMPOSITES - DESIGNED TO SURVIVE

N. CARAVASOS and J. P. DONNELLY (Boeing Vertol Co., Philadelphia, PA) IN: Composite structures; Proceedings of the National Specialists' Meeting, Philadelphia, PA, March 23-25, 1983. Washington, DC, American Helicopter Society, 1984, 7 p. refs

In the modern battlefield scenarios contemplated for military aircraft, the inherent mechanical properties of composite materials offer improved damage tolerance over comparable metallic structures. Careful tailoring of the material both reduces overall weight and improves damage tolerance through redundancy and the presentation of minimum vulnerable areas. Upon sustaining damage from armor-piercing or high explosive munitions, composites can be more quickly returned to service by means of simple field repairs. Attention is given to military helicopter composite airframe structures and the damage that they typically sustain when hit by various types of 12.7 and 23 mm projectiles. O.C.

A85-21388

ENVIRONMENTAL EFFECTS AND DURABILITY EVALUATION OF ADVANCED COMPOSITE FUSELAGE STRUCTURES

N. J. CALAPODAS (U.S. Army, Applied Technology Laboratory, Fort Eustis, VA) IN: Composite structures; Proceedings of the National Specialists' Meeting, Philadelphia, PA, March 23-25, 1983. Washington, DC, American Helicopter Society, 1984, 10 p.

An OH-58A helicopter tail section which comprises the tail boom and horizontal and vertical stabilizers has been used as a representative composite primary structure in a U.S. Army Applied Technology Laboratory program for evaluating composite helicopter structure design, fabrication and test methods. Of the 14 composite tail sections fabricated, 11 were subjected to high temperature and/or humidity environments over a period of two years. Three different reinforcing fibers were evaluated: graphite, kevlar, and

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glass. Semiannual inspections have revealed no mechanical property degradation. O.C.

A85-21396* Sikorsky Aircraft, Stratford, Conn.
COMPOSITE CURVED FRAMES FOR HELICOPTER FUSELAGE STRUCTURE

M. J. RICH and D. W. LOWRY (United Technologies Corp., Sikorsky Aircraft Div., Stratford, CT) IN: Composite structures; Proceedings of the National Specialists' Meeting, Philadelphia, PA, March 23-25, 1983. Washington, DC, American Helicopter Society, 1984, 6 p. Army-supported research.
(Contract NAS1-16826)

This paper presents the results of analysis and testing of composite curved frames. A major frame was selected from the UH-60 Black Hawk helicopter and designed as a composite structure. The curved beam effects were expected to increase flange axial stresses and induce transverse bending. A NASTRAN finite element analysis was conducted and the results were used in the design of composite curved frame specimens. Three specimens were fabricated and five static tests were conducted. The NASTRAN analysis and test results are compared for axial, transverse, and Web strains. Results show the curved beam effects are closely predicted by a NASTRAN analysis and the effects increase with loading on the composite frames. Author

A85-21397
THE ALL-COMPOSITE AIRFRAMES

R. L. FOYE (U.S. Naval Postgraduate School, Monterey, CA) IN: Composite structures; Proceedings of the National Specialists' Meeting, Philadelphia, PA, March 23-25, 1983. Washington, DC, American Helicopter Society, 1984, 9 p.

Although the concept of an all-composite airframe is over 60 years old an aerospace grade of composite material, clearly superior to aluminum, has only been available in commercial quantity for about 17 years. Since then (and even before that) there have been several serious efforts to build all-composite airframes. Discounting the gliders and home built, there have been at least 24 different all-composite airframes built and flown in the last 25 years by established airframe fabricators. Some of these like the Lear Avia 2100, Windecker Eagle, and NASA AD-1 have received considerable publicity. Others have not. This paper reviews each of the all-composite designs that have flown. Most of them have been light airframes within the private aviation sector. There are also a number of recent European powered glider designs. Author

A85-21467#
THE IMPACT OF INTEGRATED SYSTEMS - THE HELICOPTER DESIGNER'S VIEWPOINT

S. D. ROY (Westland Helicopters, Ltd., Yeovil, Somerset, England) IN: Design and advanced concepts of avionics/weapons system integration; Proceedings of the Symposium, London, England, April 3, 4, 1984. London, Royal Aeronautical Society, 1984, 6 p.

An assessment is made of the benefits of avionics system integration in the case of helicopters. The systems under consideration are noted to be highly software-intensive, and require extensive validation testing in order to ascertain any unwanted interactions between the components and functions thus integrated. It is noted that generic integrating architectures are also required to provide a basis for subsequent hardware- and application-related innovations. O.C.

A85-21844*# Texas A&M Univ., College Station.
EXPERIMENTAL AERODYNAMIC CHARACTERISTICS OF AN NACA 0012 AIRFOIL WITH SIMULATED ICE

K. D. KORKAN, E. J. CROSS, JR., and C. C. CORNELL (Texas A&M University, College Station, TX) Journal of Aircraft (ISSN 0021-8669), vol. 22, Feb. 1985, p. 130-134. Previously cited in issue 06, p. 719, Accession no. A84-17937. refs
(Contract NAG3-242)

A85-21847*# California Univ., Los Angeles.
COUPLED HELICOPTER ROTOR/BODY AEROMECHANICAL STABILITY COMPARISON OF THEORETICAL AND EXPERIMENTAL RESULTS

P. P. FRIEDMANN and C. VENKATESAN (California, University, Los Angeles, CA) Journal of Aircraft (ISSN 0021-8669), vol. 22, Feb. 1985, p. 148-155. refs
(Contract NAG2-116)

This paper presents the results of an analytical study aimed at predicting the aeromechanical stability of a helicopter in ground resonance, with the inclusions of aerodynamic forces. The theoretical results are found to be in good agreement with the experimental results, available in the literature, indicating that the coupled rotor/fuselage system can be represented by a reasonably simple mathematical model. Author

A85-22005
OPTIMIZATION OF AIRPLANE WING STRUCTURES UNDER LANDING LOADS

S. S. RAO (San Diego State University, San Diego, CA) Computers and Structures (ISSN 0045-7949), vol. 19, no. 5-6, 1984, p. 849-863. refs

A considerable amount of work has been conducted regarding the optimization of aircraft structures subjected to flutter, natural frequency, and steady state stress constraints, while not much work has been reported with respect to the optimization of aircraft structures under landing loads. The present investigation provides a deterministic methodology for the optimum design of aircraft wing structures under landing loads. The methodology is presented for automated optimum design procedures. The considered optimization procedures are illustrated with the aid of two examples. The first example involves a hollow symmetric double-wedge airfoil, while the second example is concerned with a wing which has characteristics similar to that of the 707 aircraft. G.R.

A85-22081
BURBANK'S BLACKBIRDS

J. MILLER Air International (ISSN 0306-5634), vol. 28, Feb. 1985, p. 59-64, 84-87.

A development history is presented, together with design features and performance capabilities, for the 'Blackbird' series of aircraft that encompasses SR-71 reconnaissance platforms and YA-12/A-12 interceptor test bed aircraft. Aircraft of this type have been employed by NASA as flight test aircraft; their primary design mission, however, is optical, IR and radar reconnaissance in a flight regime in excess of Mach 3 and 100,000 ft, in order to elude detection. The Y-12 has achieved Mach 3.6 in level flight. The J58 'turboramjet', rated at 32,500 lb of static thrust, has been the standard powerplant, although J75 turbojets were used initially. Both single-seat and two-seat configurations have been employed, the latter in the case of reconnaissance-dedicated and training aircraft. O.C.

A85-22273
RENEGADE 250 - FLIGHT EVALUATION OR BOAT RIDE? [RENEGADE 250 - EVALUATION EN VOL OU PROMENADE EN BATEAU?]

H. JURION Air et Cosmos (ISSN 0044-6971), vol. 22, Jan. 12, 1985, p. 12, 13. In French.

The Renegade 250 Sea Wolf, a single-engine amphibian aircraft designed for marine reconnaissance and rescue operations, is characterized on the basis of a demonstration flight. Unusual features of the aircraft include a dorsally pylon-mounted 250-hp Lycoming C4B5 engine driving a three-blade constant-velocity curved-tip pusher propeller, a vertical tail fin with a notch giving wide clearance to the elevator, and a throttle mounted on the cockpit ceiling. The ground-takeoff characteristics, cruising performance at 250 km/h, and a marine landing and takeoff are described, and photographs are provided. T.K.

A85-22373

DESIGN OF A STOL AIRCRAFT WITH JET ASSISTED TAKEOFF UNITS [K PROEKTIROVANIU SAMOLETA KOROTKOGO VZLETA I POSADKI S REAKTIVNYMI USKORITELIAMI]

A. I. BAIDIN IN: Ill-posed problems in perturbation theory (A85-22364 08-02). Novosibirsk, Izdatel'stvo Nauka, 1984, p. 235-238. In Russian.

The present study describes a technique for reducing the length of the takeoff run of a STOL aircraft by means of starting jet assisted takeoff units (JATU), mounted at a certain angle to the horizontal. The optimal value of this angle is determined on the basis of known values for the thrust of the JATU and the thrust of the sustainer engine. B.J.

N85-15665# Ministry of Defence, London (England). Materials and Structures Dept.

OPERATIONAL LOADS MEASUREMENT: A PHILOSOPHY AND ITS IMPLEMENTATION

D. M. HOLFORD and J. R. STURGEON IN AGARD Operational Loads Data 22 p Aug. 1984 refs

Avail: NTIS HC A14/MF A01

A philosophy of operational data acquisition, for structural objectives, within the general field of in-flight load measurement is reviewed, highlighting the constraints such activities place on the data acquisition system. One such system which can be tailored to perform a variety of tasks ranging from the collection of time histories of flight parameters or strain gauges to complex fatigue load analyses throughout the airframe is described. The system comprises a digital cassette recorder and a data acquisition unit within which a microprocessor is used for control of data acquisition and in-flight data analysis. System requirements in terms of accuracy, bandwidth and sampling rates are discussed for a range of aircraft types and operating conditions. The various modes of operation of the system are illustrated by examples drawn from operational experience with the system. These demonstrate the capability of the system to produce data suitable for automatic analysis in a variety of operational environments in both fixed and rotary wing aircraft. The examples clearly show the value of studying operational data in terms of fatigue life management, fatigue life monitoring, operational practices and design procedures. B.W.

N85-15666# McDonnell Aircraft Co., St. Louis, Mo. Structural Dynamics and Loads Dept.

THE F-15 FLIGHT LOADS TRACKING PROGRAM

J. T. JOHNSTON, R. E. PINCKERT, and R. A. MELLIERE IN AGARD Operational Loads Data 7 p Aug. 1984 refs

Avail: NTIS HC A14/MF A01

The F-15 flight loads tracking program is described. The tracking program consists of four phases: (1) data collection; (2) data reduction; (3) fatigue damage analysis; and (4) fleet management. Data collection is accomplished with a multi-channel recorder and a load factor (g) exceedance counter. Twenty percent of the fleet is equipped with the multi-channel recorder and every F-15 has a g exceedance counter installed. After the fleet data have been reduced by the Air Force it is sent to McDonnell Aircraft for conducting fatigue damage analyses. Quarterly Service Aircraft Fatigue Estimate (SAFE) reports inform the Air Force how much fatigue life has been expended on each aircraft. These reports are used for establishing inspections and aid in fleet management of the F-15 Eagles. This mature program, approaching, 1,000,000 flight hours, has been valuable for solving in-service structural problems, understanding why the problems occurred, developing repairs, and for redesign. Future aircraft design will also benefit from this information. B.W.

N85-15667#

National Aerospace Lab., Amsterdam (Netherlands).

STRUCTURAL LOAD MEASUREMENTS ON A NORTHROP NF-5A

D. J. SPIEKHOUT IN AGARD Operational Loads Data 15 p Aug. 1984

Avail: NTIS HC A14/MF A01

Load measurements were carried out on an NF-5A aircraft instrumented with a large number of strain gage bridges in the wing and the tail surfaces. Measurements included: (1) Specific stationary maneuvers; (2) Specific dynamic maneuver conditions; and (3) Complete mission segments typical for RNLAf-operational conditions. Using ground calibration results, recorded strains were converted to sectional loads and with flight parameters like V, H, acc. etc., stored in a structural load data base (15 flights covering 7 configurations and 715 measuring runs). By means of an interactive computer program the data stored in this data base are easily accessible. The results can be presented in tables or in graphical form. The Data Base may be used to evaluate the effect of changes in operational procedures, stores and store configurations on the fatigue load experience in various structural areas. A general description is given of the instrumentation used, the data handling and the flight conditions that were recorded. The possible use of the data base is illustrated by means of a number of examples. B.W.

N85-15668# Naval Air Development Center, Warminster, Pa. Airframe Engineering Branch.

NAVY OPERATIONAL LOADS DATA SOURCES AND SYSTEMS

A. H. JOHNSON and M. J. DUBBERLY (Naval Air Systems Command) IN AGARD Operational Loads Data 20 p Aug. 1984

Avail: NTIS HC A14/MF A01

An overview of the Navy's total Aircraft Structural Life Surveillance Program is presented. Current Fatigue Monitoring Program operational achievements and costs are described. The loads data acquisition systems for the F-14, F-18, A-7, and A-3 aircraft are also described. Future expectations regarding operational features, results, and costs are discussed. Operational loads data from the Tactical Air Combat Training System for air combat training, and the 70 mm film system for landing loads, are also described. B.W.

N85-15669# Industrieanlagen-Betriebsgesellschaft m.b.H., Ottobrunn (West Germany).

OPERATIONAL LOADS DATA EVALUATION FOR INDIVIDUAL AIRCRAFT FATIGUE MONITORING

R. SCHUETZ and R. NEUNABER IN AGARD Operational Loads Data 23 p Aug. 1984 refs

Avail: NTIS HC A14/MF A01

The utility of individual aircraft tracking (IAT) as an effective instrument for introducing the necessary maintenance activities which need to be adapted individually to each aircraft is examined. One of the most important activities within the IAT scope is the processing of operational loads data in order to calculate to consumed fatigue life of individual aircraft. The installed operational service load recording systems for military aircraft within the German Air Force include logforms, counting accelerometers and digital flight recorders. Under consideration are systems for direct measurement of loads and damage. The main activities of individual aircraft tracking include: (1) loads and component data acquisition; (2) damage calculation; (3) calculation of allowable fatigue life; (4) prediction of maintenance actions; (5) derivation of standard load sequences or spectra; (6) cost effectiveness consideration; (7) verification of fatigue load monitoring; and (8) selection of load monitoring systems. B.W.

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N85-15670# Messerschmitt-Boelkow-Blohm G.m.b.H., Toulouse (France): Airbus Program.

STRUCTURAL FLIGHT LOAD MEASUREMENT DEMONSTRATION OF STRUCTURAL INTEGRITY

E. RAUSCHER /in AGARD Operational Loads Data 9 p Aug. 1984

Avail: NTIS HC A14/MF A01

Structural flight load testing is an important part of the certification of an aircraft. Calibration of strain gauges and bridge selection and evaluation of flight parameters for fatigue and static test problems are described. Procedures presented as an example here were used for flight testing on different types as fighters and military and civilian transport aircrafts. There are several evaluation methods for short and long flight periods to check design loads for static and fatigue criteria. The Maximum Likelihood method is used to investigate aerodynamic coefficients. Counting procedures are used for statistical purposes. B.W.

N85-15674# General Dynamics Corp., Fort Worth, Tex. F-16 Loads and Criteria Dept.

F-16 FORCE MANAGEMENT, YESTERDAY, TODAY AND TOMORROW

R. L. CULP /in AGARD Operational Loads Data 15 p Aug. 1984 refs

Avail: NTIS HC A14/MF A01

United States Air Force regulations specify that a Force Management Program will be established for each aircraft system within its inventory. The approach taken by General Dynamics to fulfill the objectives of the Force Management Program for the F-16 aircraft is discussed. The methodology employed, the current status and the future plans for the F-16 Force Management Program in the areas of operational data acquisition, processing and airframe structural maintenance planning are discussed in detail. R.J.F.

N85-15675# Army Research and Technology Labs., Fort Eustis, Va. Applied Technology Lab.

US ARMY HELICOPTER OPERATIONAL FLIGHT LOADS

D. J. MERKLEY and H. K. REDDICK, JR. /in AGARD Operational Loads Data 26 p Aug. 1984 refs

Avail: NTIS HC A14/MF A01

The findings from the Army's helicopter service usage programs and the Operational Loads Survey program are discussed. The development and capability of the Structural Integrity Recording System is described. R.J.F.

N85-15676# Westland Aircraft Ltd., Yeovil (England).

HELICOPTER DATA ACQUISITION IN WHL

F. S. GRAINGER /in AGARD Operational Loads Data 17 p Aug. 1984 refs

Avail: NTIS HC A14/MF A01

An approach to loads monitoring designed to fulfil two requirements is discussed. The first requirement is the elimination, as far as possible, of costly parts being thrown away because of overly conservative assumptions with respect to usage. The second requirement is to assure the assumed safety standards by knowledge of the in-service aircraft utilization. Specific problems appropriate to the helicopter make this task more difficult, but nevertheless the fundamental steps were taken to commence data acquisition. The nature of the task requires considerable aircraft management to ensure that as many role configurations are covered as possible. Since the data is acquired in real time, the acquisition of a statistically significant amount will be spread over the next few years. Nevertheless, early signs indicate that a considerable number of improvements will be accrued from even early data received. This approach also provides the ability to encompass new roles for an in-service aircraft type, in a much more rigorous way than current estimating methods. The methodology should also provide an information database against which to test loading theories (such as random load) and extend statistical scatter knowledge on times. R.J.F.

N85-15677# Messerschmitt-Boelkow-Blohm G.m.b.H., Bremen (West Germany). Load Criteria Section.

EVALUATION OF OPERATIONAL LOADS TO VERIFY STRUCTURAL DESIGN

H. STRUCK and H. BALKE /in AGARD Operational Loads Data 16 p Aug. 1984 refs

Avail: NTIS HC A14/MF A01

A load evaluation method derived from operational maneuvers and the design requirements applied were presented. The method is based on the hypothesis that all maneuvers trained and flown by the Air Force can be standardized. Relevant parameters that are suitable to describe the maneuver time history with respect to load analysis were chosen. The standardization of maneuver parameters is demonstrated for two fighter aircraft and a few maneuver types. The correlated parameters necessary to derive structural loads, including control surface deflections can be determined, by standardized maneuvers. Operational loads on main structural components are evaluated by application of maneuver model. Extreme operational loads evaluated with the maneuver model and those determined by the design requirements are compared. E.A.K.

N85-15678# Canadair Ltd., Montreal (Quebec).

TUTOR (CL-41A) TAIL FLIGHT LOAD SURVEY

A. PAQUIN and J. SKOTNICKI (National Defence Headquarters) /in AGARD Operational Loads Data 15 p Aug. 1984 refs

Avail: NTIS HC A14/MF A01

An inflight structural failure of the Canadair Tutor aircraft horizontal tail fitting resulted in a flight load survey. An instrumented test aircraft was flown to the extremes of its structural envelope, and strains were recorded at 43 different locations on the rear fuselage and the empennage of the aircraft. The test instrumentation, the calibration performed on the test article, and the resulting formulation of load equations for estimating shear, bending moment and torque at various locations on the rear fuselage, the vertical and the horizontal stabilizer are described. The various missions and maneuvers flown to gather the necessary data and the data acquisition, verification and reduction methods are discussed. E.A.K.

N85-15679# Avions Marcel Dassault, Saint-Cloud (France).

AEROELASTIC ANALYSIS AND THE IDENTIFICATION OF FLIGHT LOADS [ANALYSE AEROELASTIQUE ET IDENTIFICATION DES CHARGES EN VOL]

C. PETIAU and M. DELAVIGNE /in AGARD Operational Loads Data 22 p Aug. 1984 refs In FRENCH

Avail: NTIS HC A14/MF A01

A coupling procedure was developed for static analysis and load calculation in which pressure loads, obtained using aerodynamic theory, are transferred directly onto the finite element model. This sophisticated method singularly complicates the problem of smoothing models of the results of wind tunnel or flight tests. Processes of identification were studied with a view to easily reflecting the results of flight tests in complex aeroelastic models and to review, as rapidly as possible, the calculations justifying the structure and the static loads from ground tests. Transl. by A.R.H.

N85-15710 Department of the Air Force, Washington, D.C.

POWERED ARTICULATED HEADREST SYSTEM Patent

A. B. McDONALD and J. T. MANNIX, inventors (to Air Force) 21 Aug. 1984 7 p Supersedes AD-D009220

(AD-D011353; US-PATENT-4,466,662;

US-PATENT-APPL-SN-320893; US-PATENT-CLASS-297-406)

Avail: US Patent and Trademark Office CSCL 01C

This patent is for a powered articulated headrest system for use with a seat structure having a backrest, such as the ejection seat of a high performance aircraft, e.g., a combat aircraft. The headrest system includes: a headrest assembly which is movably connected to the backrest; and, an electro-hydraulic actuator assembly for moving the headrest from an original (and normal) position above the backrest from an original (and normal) position above the backrest to any one of an infinite variety of positions

which are rearward and downward of the headrest, and for moving the headrest from these other positions to the original position. The actuator assembly is controlled by the occupant of the seat, e.g., the pilot of the aircraft. When the headrest is moved rearwardly, unlike the prior art, the width of the headrest decreases thereby reducing any interference with aft visibility, and the height of the headrest also decreases thereby further reducing any interference with aft visibility and also eliminating any scrubbing action between the headrest and the head of the occupant of the seat. GRA

N85-15711 Department of the Air Force, Washington, D.C.
AIRCRAFT THRUST CONTROL SCHEME FOR TERRAIN FOLLOWING SYSTEM Patent

W. C. KENDIG, inventor (to Air Force) 21 Aug. 1984 11 p
 Supersedes AD-D009357
 (AD-D011387; US-PATENT-4,467,429;
 US-PATENT-APPL-SN-339204; US-PATENT-CLASS-364-433)
 Avail: US Patent and Trademark Office CSCL 01C

This system permits speed variation within certain constraints. The minimum speed is derived from a stall avoidance or acceleration margin condition and the maximum speed may be the lower limit of the transonic region or other design limit. Assuming the throttle is set at or near a trim village, adjustments need only be made if the terrain following flight path is tending to drive the speed to one of the two velocity extremes. Velocity predictions are based on predicted kinetic energy being equal to the difference between the current kinetic energy and the potential energy to the profile extreme. The throttle is adjusted when the predicted velocity is outside the limits to add or remove the required amount of energy. Author (GRA)

N85-15712# Royal Aircraft Establishment, Farnborough (England).

THE EFFECT OF CHANGES IN THE ANGLE OF INCIDENCE IN THE EVENT OF A RICHOCHET AT A FLOAT STEP

B. E. PAVLIKEVICH Mar. 1984 11 p refs Transl. into ENGLISH from Gidromekhan. (USSR), v. 35, 1977 p 35-39 (RAE-TRANS-2120; BR93462) Avail: NTIS HC A02/MF A01

The results obtained by B. Milvitsky for the symmetrical impact of a seaplane when there is a significant change in the angle of incidence on contact with the water are examined. An expression is derived for a general dimensionless parameter which characterizes the single degree-of-freedom motion. An analytical expression is derived which relates the immersion depth to the rate of immersion of the step. R.S.F.

N85-15713*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

F-8 REFUELING BOOM GROUND VIBRATION TEST Final Report

M. W. KAHOE Jan. 1985 50 p
 (NASA-TM-84914; H-1194; NAS 1.15:84914) Avail: NTIS HC A03/MF A01 CSCL 01C

A ground vibration test was conducted on a simulated refueling boom mounted on an F-8 airplane. The ground vibration test was conducted to determine if the refueling boom modal frequencies were close to the airplane frequencies. The data presented in this report include modal frequencies, mode shape data, and structural damping coefficients. Author

N85-15714*# Boeing Commercial Airplane Co., Seattle, Wash.
SYSTEMS STUDY FOR AN INTEGRATED DIGITAL-ELECTRIC AIRCRAFT (IDEA)

G. E. TAGGE, L. A. IRISH, and A. R. BAILEY Washington NASA Jan. 1985 206 p refs
 (Contract NAS1-17528)
 (NASA-CR-3840; NAS 1.26:3840; D6-52147) Avail: NTIS HC A10/MF A01 CSCL 01C

The results of the Integrated Digital/Electric Aircraft (IDEA) Study are presented. Airplanes with advanced systems were defined and evaluated, as a means of identifying potential high payoff research tasks. A baseline airplane was defined for

comparison, typical of a 1990's airplane with advanced active controls, propulsion, aerodynamics, and structures technology. Trade studies led to definition of an IDEA airplane, with extensive digital systems and electric secondary power distribution. This airplane showed an improvement of 3% in fuel use and 1.8% in DOC relative to the baseline configuration. An alternate configuration, an advanced technology turboprop, was also evaluated, with greater improvement supported by digital electric systems. Recommended research programs were defined for high risk, high payoff areas appropriate for implementation under NASA leadership. B.W.

N85-15715*# Hughes Helicopters, Culver City, Calif.
STUDY TO ELIMINATE GROUND RESONANCE USING ACTIVE CONTROLS

F. K. STRAUB Oct. 1984 123 p refs
 (Contract NAS2-11261)
 (NASA-CR-166609; NAS 1.26:166609) Avail: NTIS HC A06/MF A01 CSCL 01C

The effectiveness of active control blade feathering in increasing rotor body damping and the possibility to eliminate ground resonance instabilities were investigated. An analytical model representing rotor flapping and lead-lag degrees of freedom and body pitch, roll, longitudinal and lateral motion is developed. Active control blade feathering is implemented as state variable feedback through a conventional swashplate. The influence of various feedback states, feedback gain, and weighting between the cyclic controls is studied through stability and response analyses. It is shown that blade cyclic inplane motion, roll rate and roll acceleration feedback can add considerable damping to the system and eliminate ground resonance instabilities, which the feedback phase is also a powerful parameter, if chosen properly, it maximizes augmentation of the inherent regressing lag mode damping. It is shown that rotor configuration parameters, like blade root hinge offset, flapping stiffness, and precone considerably influence the control effectiveness. It is found that active control is particularly powerful for hingeless and bearingless rotor systems. E.A.K.

N85-15716*# National Aeronautics and Space Administration, Washington, D. C.

INSTALLED NACELLE DRAG-IMPROVEMENT TESTS OF AN M = 0.8 TURBOPROP TRANSPORT CONFIGURATION

A. D. LEVIN and R. C. SMITH Jan. 1983 378 p refs
 (NASA-TM-84302; A-9127; NAS 1.15:84302) Avail: NTIS HC A17/MF A01 CSCL 01C

An unpowered semispan model of a representative turboprop configuration was tested to determine the effect of configuration modifications on the nonmetric body and wing juncture. It is indicated that the jet off nacelle-installation drag can be approximately 25% of the cruise drag. However, the losses can be reduced to 17% by changes to the wing leading edge and nacelle intersection. Comparison of test results from a semispan nonmetric fuselage model with those from a full span metric fuselage show differences in angles of attack produced the same lift. It is found that the constant lift drag rise of the semispan model is higher because of the increased angle of attack to achieve the same lift. E.A.K.

N85-15717*# System Planning Corp., Arlington, Va.
SPEED BENEFITS OF TILT-ROTOR DESIGNS FOR LHX Final Briefing Report, Feb. 1982

R. L. MCDANIEL, J. V. ADAMS, A. BALBERDE, S. P. DERESKA, C. J. GEARIN, and D. E. SHAW Jan. 1983 81 p
 (Contract NAS2-11020)
 (NASA-CR-166437; NAS 1.26:166437; SPC-789) Avail: NTIS HC A05/MF A01 CSCL 01A

The merits of an advanced helicopter and a tilt rotor aircraft for light utility, scout, and attack roles in combat missions envisioned for the year 2000 and beyond were compared. It is demonstrated that speed has increasing value for 11 different mission classes broadly encompassing the intended LHX roles. Helicopter speeds beyond 250 knots are judged to have lower military worth. Since the tilt rotor concept offers a different cost

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speed relationship than that of helicopters, assessment of a tilt rotor LHX variant was warranted. The technical parameters of an advanced tilt rotor are established. Parameters of representative missions are identified, computed relative value of the tilt rotor LHX are compared to the baseline helicopter, a first-order life cycle estimate for the tilt rotor LHX is established, military worth of the alternative design is computed and the results are evaluated. It is suggested that the tilt rotor is the solution with the greatest capability for meeting the uncertainties of future needs. E.A.K.

**N85-15718*# Lockheed-California Co., Burbank.
INTEGRATED TECHNOLOGY WING STUDY (ORAL
PRESENTATION)**

8 Apr. 1981 188 p

(Contract NAS1-16273)

(NASA-CR-169497; NAS 1.26:169497; LR-29801) Avail: NTIS
HC A09/MF A01 CSCL 01C

The design of a plan for a commercial transport manufacturer to integrate advanced technology into a new wing for a derivative and/or new aircraft that could enter service in the late 1980s to early 1990s time period is proposed. The development of a new wing for a derivative or a new long range commercial aircraft and the incorporation of cost effective technologies are studied. The decision provides guidelines for the best allocation of research funds. E.A.K.

**N85-15719# Army Aviation Engineering Flight Activity, Edwards
AFB, Calif.**

**UH-60A EXTERNAL STORES SUPPORT SYSTEM FIXED
PROVISION FAIRINGS DRAG DETERMINATION Final Report,
30 Aug. - 22 Sep. 1983**

R. A. WILLIAMS, R. MACMULLIN, J. O. MIESS, R. M. BUCKANIN,
and W. Y. ABBOTT May 1984 45 p

(AD-A147188; USAAEFA-82-15-1) Avail: NTIS HC A03/MF A01
CSCL 01C

A comparative performance evaluation of the UH-60A helicopter in the normal utility configuration and with the External Stores Support System (ESSS) fixed provision fairings configuration (ESSS wings removed) was conducted at Edwards AFB, Cal. A total of eight flights were flown between 30 August and 22 September 1983, for a total of 10.0 productive hours. The increase in equivalent flat plate area due to installation of the ESSS fixed provision fairings was 2.5 sq. ft. With the ESSS fixed provision fairings installed at the out-of-ground effect hover guarantee conditions of 95 percent intermediate rated power at 4700 feet pressure altitude on a 35 deg C day, the hover capability was reduced 466 pounds. Incorporating the weight of the airframe fixed provisions will reduce the payload by 596.6 pounds or the equivalent of eliminating two combat equipped troops and 117 pounds of fuel or equipment.

Author (GRA)

**N85-15720# Research Inst. of National Defence, Stockholm
(Sweden). Dept. 2.**

NYKINM, A FURTHER DEVELOPMENT OF KINM 22

K. ANDERSSON Oct. 1984 37 p refs In SWEDISH;
ENGLISH summary

(FOA-C-20559-D8(E3); ISSN-0347-3694) Avail: NTIS HC
A03/MF A01

A simulation program of a robot attack against an aircraft, which can perform only one evasive action was developed. The robot is assumed to fulfill the proportional navigation condition all the time, its path is kinematic. Performance tests, input/output routines, and the mathematical relationship for the target path (and the robot path) are given. The simulation package makes it possible to integrate vectors. Author (ESA)

**N85-16766# Joint Publications Research Service, Arlington, Va.
TESTING SOLUTION FOR IL-76 BRAKING SYSTEM PROBLEM
V. LAMZUTOV In its USSR Rept.: Transportation
(JPRS-UTR-85-001) p 6-8 15 Jan. 1985 Transl. into ENGLISH
from Vozdushnyy Transp. (Moscow), 30 Aug. 1984 p 3
Avail: NTIS HC A09/MF A01**

Landing gear buffeting was noted on IL-76 aircraft returning with only a safe fuel reserve after having delivered cargo to the North. Experimental flights revealed that the automatic braking unit was at fault. Following adjustments to the braking unit, pilots were given instruction on how to fly the aircraft so as to avoid the buffeting and how to combat buffeting should it arise. One flight conducted to determine how the unit behaves on a runway under various landing conditions and the kind of braking performance obtained is described. A.R.H.

**N85-16768# Joint Publications Research Service, Arlington, Va.
DESIGNER ON CIVIL AIRCRAFT DESIGN TRENDS IN USSR
S. YEGER In its USSR Rept.: Transportation (JPRS-UTR-85-001)
p 14-17 15 Jan. 1985 Transl. into ENGLISH from Nedelya
(Moscow), no. 33, 13-19 Aug. 1984 p 12-13
Avail: NTIS HC A09/MF A01**

Further reduction in fuel consumption, weight, and drag are drivers affecting aircraft design in the coming decades. Technology needs include more economical engines; multi-bladed propellers; improved production techniques for cabin sealing and paint thickness distribution; and short takeoff and landing aircraft. Long range routes being flown by aircraft similar to the IL-86 are foreseen. Medium haul routes should see the appearance of aircraft capable of handling 180 to 200 passengers, with more economical engines, longer wingspans, and slightly wider fuselages. Short haul aircraft should have new generation turboprop or turbofan engines.

A.R.H.

**N85-16777# National Aerospace Lab., Amsterdam
(Netherlands).**

**DESIGN OF AN AIRFOIL LEADING EDGE SLAT USING AN
INVERSE AERODYNAMIC CALCULATION METHOD**

J. A. VANEGMOND and B. VANDENBERG In AGARD
Improvement of Aerodynamic Performance Through Boundary
Layer Control and High Lift Systems 11 p Aug. 1984 refs
Avail: NTIS HC A18/MF A01

In order to evaluate the applicability of the design system MAD (multi-element airfoil design), a design study was performed for a two-dimensional wing with leading edge slat. The problem is representative for that of a transport airplane operating out of high altitude airfields requiring a high lift-to-drag ratio at takeoff. A two-dimensional high lift configuration tested earlier in a low speed wind tunnel was selected as the starting configuration. The design system MAD is described briefly. The actual leading edge slat design is given. The new slat-wing configuration as tested in a wind tunnel and some of the test results are presented together with results of the baseline configuration. R.S.F.

**N85-16780# Boeing Military Airplane Development, Seattle,
Wash.**

**AERODYNAMIC ISSUES IN THE DESIGN OF HIGH-LIFT
SYSTEMS FOR TRANSPORT AIRCRAFT**

B. DILLNER, F. W. MAY, and J. H. MCMASTERS In AGARD
Improvement of Aerodynamic Performance Through Boundary
Layer Control and High Lift Systems 22p Aug. 1984 refs
Avail: NTIS HC A18/MF A01

The design of the high lift system has a profound effect on the sizing and total performance of transport aircraft, both civil and military. The fundamentals of high lift system design are reviewed along with the phenomena that govern their performance. The computational methods available to the high lift designer, with examples of their validity, are presented. New developments in flow diagnostic techniques are reviewed. Examples of several Boeing high lift design efforts are given. Emphasis is placed on the use of computational aerodynamic methods and the synergistic effect of using those methods in parallel with testing. A list of

today's ten most important issues in high lift aerodynamics is presented. R.S.F.

N85-16781# De Havilland Aircraft Co. of Canada Ltd., Downsview (Ontario).

AN UPDATE OF THE CANADA/USA AUGMENTOR-WING PROJECT

D. C. WHITTLEY *In* AGARD Improvement of Aerodynamic Performance Through Boundary Layer Control and High Lift Systems 8 p Aug. 1984 refs

Avail: NTIS HC A18/MF A01

Following extensive tests of a half scale model in the NASA, Ames 40' x 80' wind tunnel, a minimum cost flight demonstrator was built based on the de Havilland Buffalo airframe. Following completion of the NASA trials in 1980, work has continued in Canada covering four main areas of interest using the augmentor wing powered lift concept: (1) additional flight trials on the technology demonstrator aircraft; (2) propulsion system development; (3) experimental investigation of a new compound supercritical airfoil; and (4) project definition studies. E.A.K.

N85-16782# Lockheed-Georgia Co., Marietta. Advanced Flight Sciences.

AIRCRAFT DRAG REDUCTION TECHNOLOGY

A. S. W. THOMAS *In* AGARD Improvement of Aerodynamic Performance Through Boundary Layer Control and High Lift Systems 20p Aug. 1984 refs

Avail: NTIS HC A18/MF A01

The current techniques of aircraft viscous drag reduction and some of the more recent developments that have taken place in this technology are reviewed. The various sources and relative contributions of aircraft drag are described including skin friction drag, pressure drag, interference drag and lift induced drag. The physical processes that lead to these drag contributions are emphasized and methods of reducing the impact of these drag sources are discussed. It is shown how innovative and optimized aircraft configurations can lead to drag benefits. E.A.K.

N85-16786# Technische Hogeschool, Delft (Netherlands). Dept. of Aerospace Engineering.

DESIGN STUDIES OF THICK LAMINAR FLOW AIRFOILS FOR LOW SPEED FLIGHT EMPLOYING TURBULENT BOUNDARY LAYER SUCTION OVER THE REAR PART

J. L. VANINGEN, J. J. H. BLOM, and J. H. GOEI *In* AGARD Improvement of Aerodynamic Performance Through Boundary Layer Control and High Lift Systems 19 p Aug. 1984 refs

Avail: NTIS HC A18/MF A01

Computational tools, used to analyze and design airfoils for low speed flight (prediction of potential flow pressure distributions, laminar boundary layer flows, transition prediction using the e(n) method and Head's entrainment method for the calculation of turbulent boundary layers are described. These tools are used to design pressure distributions and corresponding airfoil shape producing long runs of natural laminar flow. Inevitably this results in airfoils with the maximum thickness far backwards, eventually leading to separation of the turbulent boundary layer over the rear part of the airfoil. This turbulent boundary layer separation is prevented by selecting a proper pressure distribution over the rear part and/or suction of the turbulent boundary layer through slots or distributed perforations. Design charts are presented which help to select the required pressure distributions for laminar and turbulent flow. B.W.

N85-16790*# Aeronautical Research Inst. of Sweden, Bromma. **FULL SCALE EXPERIMENTS INTO THE USE OF LARGE EDDY BREAKUP DEVICES FOR DRAG REDUCTION ON AIRCRAFT**

A. BERTELROD *In* AGARD Improvement of Aerodynamic Performance Through Boundary Layer Control and High Lift Systems 16 p Aug. 1984 refs

Avail: NTIS HC A18/MF A01

An experimental investigation in flight was performed to explore the feasibility of using LEBU (Large-Eddy-Breakup) devices to reduce the drag of aircraft. Two geometrical shapes of ribbons

were used, and the development of local skin friction was monitored downstream. The aircraft was a swept-wing attack aircraft, and the flights covered the entire subsonic regime from $M=0.92$ down to stall conditions; flight altitudes were 1, 4.5, 7 and 10 km to explore various combinations of angle of attack, Mach - and Reynolds numbers. Some information was obtained concerning the turbulence characteristics downstream, and a discussion of the downstream amplification due to the drag at the device is also presented. B.W.

N85-16791# Technische Hogeschool, Delft (Netherlands).

PNEUMATIC TURBULATORS: A DEVICE FOR DRAG REDUCTION AT REYNOLDS NUMBERS BELOW 5 MILLION

K. H. HORSTMANN, A. QUAST, and L. M. M. BOERMANS *In* AGARD Improvement of Aerodynamic Performance Through Boundary Layer Control and High Lift Systems 19 p Aug. 1984 refs

Avail: NTIS HC A18/MF A01

At Reynolds numbers below 5 million, airfoils are affected by laminar separation bubbles which in many cases considerably increase the drag. By blowing air from a row of orifices at the beginning of the laminar separation bubble, the bubble can be prevented and the drag can be reduced substantially. This device is called a pneumatic turbulator. Free-stream total pressure is sufficient to provide the turbulator bleed air. The additional drag caused by the bleed air and the air jets is negligible. The low drag Reynolds number range of laminar airfoils can be extended by using pneumatic turbulators. R.J.F.

N85-16818# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (West Germany).

FLIGHT TESTS WITH A NEW HELICOPTER FORCE FEEL SYSTEM (FFS)

R. D. VONRETH, H. KOENIG, and G. TURCK *In* AGARD Helicopter Guidance and Control Systems for Battlefield Support 11 p Aug. 1984 refs

Avail: NTIS HC A13/MF A01

An artificial force feel system for the control of the pitch and roll axes of a Bo 105 helicopter was studied. Goals of the program were to investigate if the use of such an artificial force feel system for the helicopter control would increase flight safety, allow a more precise control of a flight path, increase stability, and reduce pilot workload. An experimental flight worthy system using the electro-hydraulic actuators for the pitch and roll axis respectively was implemented in the flying simulator Bo 105-53. A number of different force control laws were derived and flight tested. Although some contributions to the total control force were rated very differently by the various test pilots (e.g., contributions from the normal acceleration), as a general trend very favorable ratings were obtained. Two examples of these favorable ratings for highly dynamic maneuvers (slalom and dolphin) are an improved stability of the trim state and an improved flight path control in general. M.G.

N85-16861*# Lockheed-California Co., Burbank.

INTEGRATED DIGITAL/ELECTRIC AIRCRAFT CONCEPTS STUDY Contractor Report, Oct. 1983 - Sep. 1984

M. J. CRONIN, A. P. HAYS, F. B. GREEN, N. A. RADOVICH, C. W. HELSLEY, and W. L. RUTCHIK Washington NASA Jan. 1985 464 p refs

(Contract NAS1-17529)

(NASA-CR-3841; NAS 1.26:3841; LR-30704) Avail: NTIS HC A20/MF A01 CSCL 01C

The integrated digital/electrical aircraft (IDEA) is an aircraft concept which employs all electric secondary power systems and advanced digital flight control systems. After trade analysis, preferred systems were applied to the baseline configuration. An additional configuration, the alternate IDEA, was also considered. For this concept the design ground rules were relaxed in order to quantify additional synergistic benefits. It was proposed that an IDEA configuration and technical risks associated with the IDEA systems concepts be defined and the research and development required activities to reduce these risks be identified. The selected

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subsystems include: power generation, power distribution, actuators, environmental control system and flight controls systems. When the aircraft was resized, block fuel was predicted to decrease by 11.3 percent, with 7.9 percent decrease in direct operating cost. The alternate IDEA shows a further 3.4 percent reduction in block fuel and 3.1 percent reduction in direct operating cost.

R.S.F.

N85-16862*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

STUDY OF WINGLETS APPLIED TO BIPLANES

P. D. GALL and H. C. SMITH (Pennsylvania State Univ.) Jan. 1985 21 p refs Presented at the 23rd AIAA Aerospace Sci. Meeting, Reno, Nev., 14-17 Jan. 1985 Submitted for publication (NASA-TM-86350; NAS 1.15:86350; AIAA-85-0279) Avail: NTIS HC A02/MF A01 CSCL 01C

The possibility of improving the aerodynamic characteristics of a biplane configuration by adding winglets is examined both theoretically and experimentally. Theoretical calculations show good agreement with experiment in predicting inviscid drag due to lift. Theoretical and experimental results indicate that the addition of winglets to an optimized biplane configuration can increase the ideal efficiency factor by up to 13 percent, as well as increasing the lift curve slope and maximum lift coefficient.

B.W.

N85-16864# Army Aviation Engineering Flight Activity, Edwards AFB, Calif.

AIRWORTHINESS AND FLIGHT CHARACTERISTICS TEST OF THE RC-12D GUARDRAIL V Final Report, 10 May - 1 Jun. 1984

G. M. YAMAKAWA, J. L. WEBRE, R. S. ADLER, and R. E. RATCLIFF Jul. 1984 73 p (Contract AF PROJ. 8402)

(AD-A148046; AD-E850735; USAAEFA-84-02) Avail: NTIS HC A04/MF A01 CSCL 01B

The US Army Aviation Engineering Flight Activity conducted a limited Airworthiness and Flight Characteristics test of the RC-12D (Improved Guardrail V) aircraft with both standard and infrared (IR) suppressor exhaust stacks installed from 10 May through 1 June 1984 at Wichita, Kansas. During the test program, 12 flights were conducted for a total of 25.7 hours, of which 14.6 were productive. All tests were performed in a normal mission configuration ballasted to a maximum takeoff gross weight of 14,200 pounds and a center of gravity at fuselage station 190.1 (fwd). Test results were compared with data obtained during previous testing, and evaluated against military specification MIL-F-8785C. Takeoff and landing performance presented in the operator's manual were confirmed as was the Beech Aircraft Corporation provided drag polar plot of the standard stack configured aircraft. A slight degradation in performance was noted with IR suppressor exhaust stacks installed. The RC-12D aircraft has marginal climb performance capabilities with a combat ceiling below 24,000 feet density altitude. The handling qualities of the RC-12D with both standard and IR suppressor exhaust stacks installed were essentially unchanged from the standard C-12D aircraft with the exception of improved stall characteristics. GRA

N85-16865# Army Aviation Engineering Flight Activity, Edwards AFB, Calif.

PRELIMINARY AIRWORTHINESS EVALUATION AH-1S (MC) HELICOPTER WITH EXTERNAL FUEL TANKS INSTALLED Final Report, 17 Mar. - 27 Apr. 1984

J. I. NAGATA, J. S. VOSS, and R. A. WILLIAMS Jul. 1984 93 p

(AD-A148091; USAAEFA-84-09) Avail: NTIS HC A05/MF A01 CSCL 01C

The Preliminary Airworthiness Evaluation of the AH-1S Modernized Cobra, (S/N 69-16423) with the Kellett ferry tanks installed was conducted at Edwards Air Force Base, California (2302 feet) and Bakersfield, California (488 feet). Approximately 19 productive hours were flown during 24 flights between 17 March and 27 April 1984. The Kellett ferry tanks increased the equivalent flat plate area by 2.0 sq ft. One deficiency noted during the

evaluation was the lack of crashworthiness of the external fuel tanks. Four shortcomings associated with the installation of the external fuel tanks were found.

GRA

N85-16866# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Systems and Logistics.

A DESCRIPTION OF A LOGISTICALLY IDEAL AIRCRAFT M.S. Thesis

J. O. CAMPBELL and J. D. CARLIN Sep. 1984 84 p (AD-A148425; AFIT/GSM/LSY/84S-5) Avail: NTIS HC A05/MF A01 CSCL 01C

The purpose of this thesis was to develop a description of a logistics ideal aircraft. A survey was conducted of senior Air Force logisticians and distinguished civilian logisticians. The Delphi methodology was used to elicit expert opinion concerning major logistics problems in current generation aircraft and ways to avoid these problems in future generation aircraft. These problems and solutions were used to describe the logistics ideal aircraft. GRA

N85-16867# Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio.

OPTIMUM PERFORMANCE PARAMETERS FOR SKI-JUMP OPERATIONS OF USAF FIGHTER AIRCRAFT

J. J. OLSEN Aug. 1984 42 p

(Contract AF PROJ. 2401)

(AD-A148532; AFWAL-TM-84-217-FIB) Avail: NTIS HC A03/MF A01 CSCL 01B

This paper discusses the equations of motion which govern the aerodynamic performance of USAF fighter aircraft immediately after ski-jump takeoffs. By a careful selection of coordinate systems and independent and dependent variables, we eliminate the need for repetitive time-history integration of the nonlinear, coupled equations. This allows a relatively simple, but exact solution of the problem. Detailed results are presented for the F-4, A-10, F-15 and F-16 for two cases -- a nominal baseline for constant pitch attitude, and a best possible case which produces the lowest achievable takeoff speeds.

Author (GRA)

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AIRCRAFT INSTRUMENTATION

Includes cockpit and cabin display devices; and flight instruments.

A85-21555*# Lockheed-Georgia Co., Marietta.

PILOT'S DESK FLIGHT STATION

G. A. SEXTON (Lockheed-Georgia Co., Marietta, GA) IN: Symposium on Aviation Psychology, 2nd, Columbus, OH, April 25-28, 1983, Proceedings. Columbus, OH, Ohio State University, 1984, p. 27-36.

(Contract NAS1-16199)

Aircraft flight station designs have generally evolved through the incorporation of improved or modernized controls and displays. In connection with a continuing increase in the amount of information displayed, this process has produced a complex and cluttered conglomeration of knobs, switches, and electromechanical displays. The result was often high crew workload, missed signals, and misinterpreted information. Advances in electronic technology have now, however, led to new concepts in flight station design. An American aerospace company in cooperation with NASA has utilized these concepts to develop a candidate conceptual design for a 1995 flight station. The obtained Pilot's Desk Flight Station is a unique design which resembles more an operator's console than today's cockpit. Attention is given to configuration, primary flight controllers, front panel displays, flight/navigation display, approach charts and weather display, head-up display, and voice command and response systems.

G.R.

A85-21559#

THE COCKPIT DISPLAY OF TRAFFIC INFORMATION AND THE THREAT ALERT AND COLLISION AVOIDANCE SYSTEM INTEGRATION - A REVIEW

P. T. LESTER (San Jose State University, San Jose, CA) and E. E. QUAN, JR. (California, University, Berkeley, CA) IN: Symposium on Aviation Psychology, 2nd, Columbus, OH, April 25-28, 1983, Proceedings. Columbus, OH, Ohio State University, 1984, p. 69-75. refs

The Cockpit Display of Traffic Information (CDTI) and the Threat Alert and Collision Avoidance System (TCAS) integration will display traffic in the vicinity of an aircraft and issue maneuver commands to pilots to aid in the prevention of aircraft collisions. Discussed were the effects of adding more displays to an increasingly automated cockpit and the consequences of changing the design of aircraft from three to two man crews when using the CDTI/TCAS system. Studies were analyzed to find efficient display symbology for the CDTI, the problem of false alarms and their effect on pilot confidence in the CDTI/TCAS system, and the problem of pilot disagreement with TCAS commands. The authors suggest that the TCAS commands be closer to the pilot's maneuver of choice, and that additional studies are needed concerning the time a pilot must spend to utilize the CDTI and the effectiveness of the CDTI/TCAS system in areas with high air traffic densities.

Author

A85-21593#

CONTRAST SENSITIVITY PERFORMANCE ASSESSMENT OF HUD DISPLAY SYSTEMS

A. P. GINSBURG, W. L. MARTIN, and H. SELF (USAF, Aerospace Medical Research Laboratory, Wright-Patterson AFB, OH) IN: Symposium on Aviation Psychology, 2nd, Columbus, OH, April 25-28, 1983, Proceedings. Columbus, OH, Ohio State University, 1984, p. 473-480. refs

The contrast losses of three head-up displays (HUD) having either reflective or refractive optical systems were determined from contrast sensitivity measurements under laboratory and field conditions. Contrast sensitivity losses resulting from the HUD optics due to transmittance, glare and reflections were translated into detection range losses using previously collected field trial data that related differences in detection range of Air Force pilots to differences in their contrast sensitivity. Agreements in detection range loss penalties using this direct approach and traditional approaches are good. In general, these three quite different HUDs produce similar losses in detection range.

Author

N85-15721 Department of the Air Force, Washington, D.C.

BIODYNAMIC RESISTANT CONTROL STICK Patent

D. W. REPPERGER, inventor (to Air Force) 16 Oct. 1984 20 p Supersedes AD-D010034

(AD-D011380; US-PATENT-4,477,043;

US-PATENT-APPL-SN-449922; US-PATENT-CLASS-244-223)

Avail: US Patent and Trademark Office CSCL 01C

This patent presents an improvement to an aircraft control stick is disclosed. Movement of an aircraft may generate a force which undesirably causes the aircraft pilot to deflect the aircraft's control stick, which thereby results in the aircraft deviating from the desired flight path. The present invention includes a processor-based system which employs an algorithm that generates a signal for causing the control stick to resist such forces. The invention includes a spring and damper connected to the control stick so that the spring constant and damping ratio may be varied.

GRA

N85-15722# McDonnell Aircraft Co., St. Louis, Mo.

DISPLAY TECHNIQUES FOR ADVANCED CREW STATIONS (DTACS). PHASE 1: DISPLAY TECHNIQUES STUDY Final Technical Report, Apr. 1983 - Oct. 1984

E. C. ADAM, H. E. DILLARD, R. M. VELTEN, and J. GUENTHER Wright-Patterson AFB, Ohio AFWAL Mar. 1984 130 p (Contract F33615-83-C-1040)

(AD-A146922; AFWAL-TR-84-1016) Avail: NTIS HC A07/MF A01 CSCL 01C

The DTACS Final Report describes the study which explored advanced display techniques and their effect on future fighter/attack aircraft crew stations. The emphasis was placed on new and developing technology with applications to integrated avionics systems. Future mission requirements were reviewed, display requirements were established, display technologies were reviewed, an initial configuration of an advanced display was made and a plan for further development was also prepared. GRA

N85-16799# Ferranti Ltd., Edinburgh (Scotland). Navigation Systems Dept.

AUTOMATIC BRIEFING AND MISSION MANAGEMENT SYSTEMS FOR BATTLEFIELD SUPPORT

C. G. W. ROADS IN AGARD Helicopter Guidance and Control Systems for Battlefield Support 6 p Aug. 1984 refs

Avail: NTIS HC A13/MF A01

Mission planning and briefing systems were used for almost a decade to make the best use of advanced avionics fitted to high performance fixed-wing aircraft. As similar equipment is fitted to helicopters to enable them to perform on the battlefield the need for mission briefing systems will become apparent. How such a system might be used in the context of a hypothetical future operation is described and in doing so seeks to highlight some of the technical problems which will be encountered in developing and fielding such equipment. The interaction of the databases which could be exploited by such system are considered, and whether the equipment in service today is developing towards the future systems described. B.G.

N85-16800# Anacapa Sciences, Inc., Santa Barbara, Calif.

A COMPUTER-GENERATED TOPOGRAPHIC DISPLAY SYSTEM FOR NAVIGATION AND MISSION PLANNING IN HELICOPTERS

S. P. ROGERS IN AGARD Helicopter Guidance and Control Systems for Battlefield Support 11 p Aug. 1984 refs

Avail: NTIS HC A13/MF A01

The Integrated Mission-Planning Station (IMPS) is a computer-generated topographic display system. The IMPS will provide not only a greatly enhanced navigation capability, but also a combination of dramatic improvements in cartographic support, map information content, and aviator-map interactions. The powerful computational capability of the IMPS can be used to present a shaded relief map, to display areas masked from visual or radar observation, to construct perspective views of key terrain, to support a self-contained terrain correlation navigation system, and to permit rapid solutions to problems of previously forbidding complexity. The tasks conducted to provide detailed human factors engineering specifications for the construction and programming are described. The outcome of these efforts is described in terms of an overview of system components and functions. Each of the major functions of the IMPS system is discussed, and the operational requirements, present deficiencies, and IMPS capabilities are identified. Author

N85-16801# Thomson-CSF, Issy les Moulineaux (France).

MAP DISPLAY FOR HELICOPTERS

P. CHOLLE IN AGARD Helicopter Guidance and Control Systems for Battlefield Support 16 p Aug. 1984 refs IN ENGLISH and FRENCH

Avail: NTIS HC A13/MF A01

Modern combat helicopters have to be adapted to a context of constantly increasing crew work load. The electronic map display is a way to greatly reduce navigation tasks. Present position of the aircraft is continuously provided and allows for very fast

navigation up-dating, North-up and Track-up modes are also possible. A continuous zoom is used to enlarge some details. A joystick is used to manually move the map for visualization of other zones. Different maps scales are available. If the helicopter's display system is powerful enough it is also possible to create an interactive console giving the crew the ability to memorize data on the map before the mission and in real time during the flight.

Author

N85-16805# Racal Avionics Ltd., New Malden (England).
INTEGRATED CONTROL AND DISPLAY SYSTEMS FOR HELICOPTER BATTLEFIELD MISSION MANAGEMENT
 M. A. RICHARDSON /In AGARD Helicopter Guidance and Control Systems for Battlefield Support 7 p Aug. 1984
 Avail: NTIS HC A13/MF A01

The avionics requirements of an integrated crew station for battlefield helicopters are discussed. An example of the approach taken to equip a multi-role light attack helicopter is provided.

B.W.

N85-16806# Societe de Fabrication d'Instruments de Mesure, Massy (France).
A DIGITAL PILOTING SYSTEM FOR THE COMBAT HELICOPTER [SYSTEME NUMERIQUE DE PILOTAGE POUR HELICOPTERE DE COMBAT]
 J. C. DERRIEN /In AGARD Helicopter Guidance and Control Systems for Battlefield Support 13 p Aug. 1984 refs In FRENCH
 Avail: NTIS HC A13/MF A01

For several years, SFIM has specialized in the development of digital systems for piloting the helicopter. A sophisticated environment for simulation for the design of future systems has been created and used in recent years for the design and adjustment of systems for complete in-flight evaluation on several types of helicopters. General methods for the design and integration of such systems, the PAN 1 digital piloting system coupled to the 26SH strap-down attitude unit, and an HCL coupling system for hovering which is itself, connected to the VENUS pointing system are discussed. The system being developed at SFIM which was completely adapted for the combat helicopter is examined.

Transl. by A.R.H.

N85-16808# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (West Germany).
EVALUATION OF NOSE, ROOF, AND MAST MOUNTED SENSOR PLATFORMS FOR PILOTING AND SIGHTING, INTEGRATED IN FUTURE COMBAT HELICOPTERS
 H. D. V. BOEHM and R. D. V. RETH /In AGARD Helicopter Guidance and Control Systems for Battlefield Support 16 p Aug. 1984 refs
 Avail: NTIS HC A13/MF A01

The piloting and sighting tasks under day, night and adverse weather conditions for a combat helicopter are different. For sighting the helicopter needs a well adapted sensor package, which may consist of a high performance FLIR, a direct view glass optic, a TV-channel and a tracker with a boresighting module. For the piloting task it is possible to use a complex sensor system including a helmet mounted sight and display (HMS/D) and/or night vision goggles (NVG). Different aspects of nose-, roof-, and mast-mounted sights (NMS, RMS, NMS) for a gunner and present and future weapon systems are discussed. Advanced electro-optical systems with a high performance telescope, allowing an increased combat range are considered. An advanced multisensor approach where the more conventional systems are supplemented or partially replaced by a multimode imaging radar is examined. The sensor for piloting can be integrated with the sighting system or located in a position remote from the sight. The pilot needs a dedicated display in the form of either a head-down display (HDD) or a helmet mounted display (HMD). A superimposed symbology adapted to the phase of the mission e.g., cruise, transition or hover, is required in either case.

E.A.K.

N85-16809# Crouzet Aerospace and Systems, Valence (France).

RECENT METHODS FOR CALIBRATING THE ANEMOMETRY OF HELICOPTERS AT LOW SPEEDS [NOVELLES METHODES D'ETALONNAGE DE L'ANEMOMETRIE DES HELICOPTERES AUX BASSES VITESSES]

J. MANDLE /In AGARD Helicopter Guidance and Control Systems for Battlefield Support 12 p Aug. 1984 refs In FRENCH
 Avail: NTIS HC A13/MF A01

Improvements made by Crouzet to make classic methods of calibrating anemometry compatible with the flight domain of helicopters are discussed as well as proposed new material. The limitations of the classic methods are examined, the improvements defined, and equipment installed for these new methods at the Brittany Flight Test Center are described. Transl. by A.R.H.

N85-16811# Westland Helicopters Ltd., Yeovil (England).
THE DESIGN AND DEVELOPMENT OF AN INTEGRATED CORE SYSTEM FOR BATTLEFIELD HELICOPTERS

S. D. ROY and P. L. SHILLITO /In AGARD Helicopter Guidance and Control Systems for Battlefield Support 10 p Aug. 1984 refs
 Avail: NTIS HC A13/MF A01

Integrated control systems for Lynx and Westland combat helicopters are discussed. Navigation, communications, and weapons systems integration is addressed, as well as an architecture which not only enables the crew to manage and control the systems and aircraft on the battlefield, but provides a means of extending the performance of the total system-crew, avionics, and aircraft.

R.J.F.

N85-16812# Army Avionics Research and Development Activity, Fort Monmouth, N. J.

EVOLUTION TOWARD A MULTI-BUS ARCHITECTURE FOR ARMY HELICOPTER AVIONIC SYSTEMS

J. A. DASARO /In AGARD Helicopter Guidance and Control Systems for Battlefield Support 7 p Aug. 1984 refs
 Avail: NTIS HC A13/MF A01

An attempt to arrive at an architecture which fits the avionics technology available today and that which will be available in the near future is described. Current efforts to implement this technology in the U.S. Army Avionics Laboratory are using currently available microprocessors configured as a multiprocessor and an available Ada compiler. A procurement strategy evolved in parallel with this architecture that uses form, fit, function specifications and interface control documents so as not to restrict future procurements to today's technology. Certainly much work remains to be accomplished to evolve the concept presented here; however, it is fully expected that over the next several years, enough experience should be gained to achieve an architecture that should meet the needs for the demanding helicopter missions of the future.

A.R.H.

N85-16813# Bell Helicopter Co., Fort Worth, Tex.
INTEGRATION OF SENSOR FUSION IN ADVANCED HELICOPTER COCKPIT DESIGN

G. L. COHILL, D. D. STROTHER, and H. B. HENDERSON (Texas Instruments, Dallas, Tex.) /In AGARD Helicopter Guidance and Control Systems for Battlefield Support 9 p Aug. 1984
 Avail: NTIS HC A13/MF A01

Effective operation and survival in the battlefield of the future can impose great demands on helicopter weapon systems and the crews who manage them. Among these are: time to detect and respond to threats and targets; ability to integrate many types of sensor data and assess the intelligence portrayed by these sensors; and requirements for highly trained systems management personnel who can process highly technical information while operating in the very demanding NOE environment. Helicopter cockpit designs for the future and how crew performance can be improved are discussed and subsystems are addressed which can improve human performance. Sensor fusion systems, related misconceptions and their proposed use are highlighted. It is shown that the fused system is more reliable, less costly, lighter, and

has more performance potential. System fusion provides a way to unload the harried system operator and assure mission success at a cost/performance ratio that decreases proportionally with overall system complexity. A.R.H.

N85-16820# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany).

FLIGHT RESEARCH ON VISUAL AIDS AND NAVIGATION EQUIPMENT FOR HELICOPTER LOW-LEVEL FLIGHT AT NIGHT

R. BEYER / In AGARD Helicopter Guidance and Control Systems for Battlefield Support 8 p Aug. 1984 refs
Avail: NTIS HC A13/MF A01

An avionic/optronic system comprising night goggles, electronic head down display and Doppler navigation was tested in a Bo 105 helicopter in low level flight at night. Particular emphasis was given to the assessment of system performance and pilot workload. The results obtained as well as the methods and procedures applied are discussed in a way that similar experiments in the future may benefit from the outcome. Author

N85-16821*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

DEVELOPMENT AND FLIGHT TEST OF A HELICOPTER COMPACT, PORTABLE, PRECISION LANDING SYSTEM CONCEPT

J. S. BULL, G. R. CLARY, T. J. DAVIS, and J. P. CHISHOLM (Sierra Nevada Corp., Reno) / In AGARD Helicopter Guidance and Control Systems for Battlefield Support 8 p Aug. 1984 refs
Previously announced as N84-24566
Avail: NTIS HC A13/MF A01 CSCL 01D

An airborne, radar based, precision approach concept is being developed and flight tested as a part of NASA's Rotorcraft All-Weather Operations Research Program. A transponder based beacon landing system (BLS) applying state of the art X band radar technology and digital processing techniques, has been built and is being flight tested to demonstrate the concept feasibility. The BLS airborne hardware consists of an add on microprocessor, installed in conjunction with the aircraft weather/mapping radar, which analyzes the radar beacon receiver returns and determines range, localizer deviation, and glide slope derivation. The ground station is an inexpensive, portable unit which can be quickly deployed at a landing site. Results from the flight test program show that the BLS concept has a significant potential for providing rotorcraft with low cost, precision instrument approach capability in remote areas. Author

N85-16868*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

REFERENCE ENERGY-ALTITUDE DESCENT GUIDANCE: SIMULATOR EVALUATION

K. H. ABBOT and C. E. KNOX Jan. 1985 39 p refs
(NASA-TP-2383; L-15800; NAS 1.60:2383) Avail: NTIS HC A03/MF A01 CSCL 01D

Descent guidance was developed to provide a pilot with information to take a fuel-conservative descent and cross a designated geographical waypoint at a preselected altitude and airspeed. The guidance was designed to reduce fuel usage during the descent and reduce the mental work load associated with planning a fuel-conservative descent. A piloted simulation was conducted to evaluate the operational use of this guidance concept. The results of the simulation tests show that the use of the guidance reduced fuel consumption and mental work load during the descent. Use of the guidance also decreased the airspeed error, but had no effect on the altitude error when the designated waypoint was crossed. Physical work load increased with the use of the guidance, but remained well within acceptable levels. The pilots found the guidance easy to use as presented and reported that it would be useful in an operational environment. Author

N85-16869*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

A COCKPIT-DISPLAY CONCEPT FOR EXECUTING A MULTIPLE GLIDE-SLOPE APPROACH FOR WAKE-VORTEX AVOIDANCE

T. S. ABBOTT Feb. 1984 44 p refs
(NASA-TP-2386; L-15852; NAS 1.60:2386) Avail: NTIS HC A03/MF A01 CSCL 01D

A piloted simulation study was undertaken to determine the feasibility of utilizing a forward-looking display to provide information that would enable aircraft to reduce their in-trail separation interval, and hence increase airport capacity, through the application of multiple glide-path approach techniques. The primary objective of this study was to determine whether information could be satisfactorily provided on a head-up display (HUD) format to permit the pilot to conduct a multiple glide-slope approach while maintaining a prespecified in-trail separation interval. The tests were conducted in a motion-base cockpit simulator configured as a current-generation transport aircraft and included dynamic effects of the vortices generated by the lead aircraft. The information provided on the HUD included typical aircraft guidance information and the current and past positions of the lead aircraft. Additionally, the displayed information provided self-separation cues that allowed the pilot to maintain separation on the lead aircraft. Performance data and pilot subjective ratings and comments were obtained during the tests. The results of this study indicate that multiple glide-slope approaches, procedurally designed for vortex avoidance, are possible while maintaining pilot work load and performance within operationally acceptable limits. In general, it would seem that multiple glide-slope approaches are possible even under reduced in-trail separation conditions if the pilot is provided with adequate situational information. Author

N85-16870# Royal Aircraft Establishment, Farnborough (England).

ON-BOARD PROCESSING FOR LINESCAN SENSORS IN MINIATURE UNMANNED AIRCRAFT

J. A. C. BEATTIE 10 Jan. 1984 21 p refs
(RAE-TM-SPACE-327; BR91753) Avail: NTIS HC A02/MF A01

The characteristics of linescan imagery are identified, and for those suitable for on-board processing in unmanned aircraft, the parameters and limits of operation are shown. Bandwidth reduction and information extraction may be enhanced or supplemented by on-board processing to prefilter the data for target detection and target motion detection. Full use of automatic target detection can only be made in conjunction with a navigation system to give ground coordinates for the target data. Alternatively, navigation and air vehicle attitude data can be obtained from the on-board linescan image processor, given the appropriate sensor and processing algorithms. Author (ESA)

N85-16871# Rohde and Schwartz, Munich (West Germany). Unternehmensbereich Betriebsfunktechnik.

DEVELOPMENT, PRODUCTION AND TESTING OF CENTRAL CONTROL AND DISPLAY UNIT FOR HELICOPTERS Final Report, Dec. 1983

W. BRUECKNER Bonn Bundesministerium fuer Forschung und Technologie Oct. 1984 54 p In GERMAN; ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie (BMFT-FB-W-84-039; ISSN-0170-1339) Avail: NTIS HC A04/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 11

Central control of avionics systems is discussed. The individual control units monitoring avionics systems integrated in helicopters were replaced by a microprocessor controlled central control and display unit consisting of an alphanumeric display, a keypad for the entry of characters as well as softkeys for selecting the operating modes. A program was developed according to an operational philosophy complying with human engineering requirements. The unit was tested in flight and shows good results. Author (ESA)

N85-16872# VDO-Luftfahrtgeraete Werk Adolf Schindling G.m.b.H., Frankfurt (West Germany). Bereich Luftfahrt. **REALIZATION AND TESTING OF AN EXPERIMENTAL COLOR DISPLAY SYSTEM FOR GENERAL AVIATION HELICOPTERS AND AIRCRAFT Final Report, Apr. 1984**

H. W. FISCHER, M. GROSSKOPF, and R. SCHOENNAGEL Bonn Bundesministerium fuer Forschung und Technologie Oct. 1984 67 p In GERMAN; ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie (BMFT-FB-W-84-042; ISSN-0170-1339) Avail: NTIS HC A04/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 14

An experimental color display system, consisting of a 5 x 5 in monitor with cathode ray tube and a computer/symbol generator, was built and installed in a BO 105 helicopter for testing. The equipment was developed by modification of the cockpit components of the Airbus A 310 in order to reduce costs. For the tests all indicators required for flight were integrated in a compact and comprehensive way in one display. Owing to the good results of the tests with one display, the system was extended (hardware and software) by a second display for presenting all engine data.

Author (ESA)

A85-19509*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

COMPUTATIONAL THERMO-FLUID DYNAMICS CONTRIBUTIONS TO ADVANCED GAS TURBINE ENGINE DESIGN

R. W. GRAHAM, J. J. ADAMCZYK, and H. E. ROHLIK (NASA, Lewis Research Center, Cleveland, OH) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 10 p. Previously announced in STAR as N85-10069. refs

(AIAA PAPER 85-0083)

The design practices for the gas turbine are traced throughout history with particular emphasis on the calculational or analytical methods. Three principal components of the gas turbine engine will be considered: namely, the compressor, the combustor and the turbine.

B.W.

07

AIRCRAFT PROPULSION AND POWER

Includes prime propulsion systems and systems components, e.g., gas turbine engines and compressors; and on-board auxiliary power plants for aircraft.

A85-19453# **ANALYSIS OF COUNTER-ROTATING PROPELLER PERFORMANCE**

F. J. DAVENPORT, J. L. COLEHOUR (Boeing Commercial Airplane Co., Seattle, WA), and J. S. SOKHEY (General Electric Co., Aircraft Engine Business Group, Evendale, OH) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 14 p. refs (AIAA PAPER 85-0005)

The paper discusses calculation of the performance of counter-rotating propellers, assuming quasi-steady interference effects between rotors. Both lifting-line ('strip theory') and three-dimensional rotating-coordinate Euler-equation methods are considered. It is argued that the much simpler strip-theory method can give useful results even for swept blades that are partially supersonic, by using 'synthetic' section data that implicitly include sweep and supersonic-flow effects. Calculations for a 5+5-blade counter-rotating propeller indicate 6 percent better efficiency at 35 percent higher design power loading than an 8-blade single-rotation rotor having similar planform and profiles. Euler-equation solutions of counter-rotating propeller flows are calculated by enforcing 'inlet' and 'exit' flow properties at a pair of mesh surfaces approximating the location of the interfering rotor. Stable and reasonable solutions are obtained, although loadings appear higher than would be expected for a given pitch setting. The difference is attributed to the neglect of viscosity. Author

A85-19525#

A ZONAL COMPUTATIONAL APPROACH TO THRUST AUGMENTOR OPTIMIZATION

T. S. LUND, D. A. TAVELLA, and L. ROBERTS (Stanford University, Stanford, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 9 p. refs

(AIAA PAPER 85-0110)

A viscous-inviscid interaction methodology based on a zonal description of the flowfield is developed as a means of predicting the performance of two-dimensional thrust augmenting ejectors. An inviscid zone comprising the irrotational flow about the device is patched together with a viscous zone containing the turbulent mixing flow. The inviscid region is computed by a higher order panel method, while an integral method is used for the description of the viscous part. A non-linear, constrained optimization study is undertaken for the design of the inlet region. In this study, the viscous-inviscid analysis is complemented with an algebraic penalty function to account for flow separation. The thrust-based Reynolds number as well as the free stream velocity are shown to be important parameters in the design of a thrust augmentor inlet.

Author

A85-19615#

REAL GAS EFFECTS IN ADVANCED TECHNOLOGY ENGINES

W. E. SIMPKIN and C. A. CORBETT (LTV Aerospace and Defense Co., Dallas, TX) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 6 p. refs (AIAA PAPER 85-0252)

The results of cycle analyses of high temperature turbine and ramjet engines using several high energy density fuels show traditional engine performance computer programs can be misleading. Engine performance using heavy hydrocarbon or slurry fuels with 3500 F burner temperatures requires a direct evaluation of the thermodynamic properties of the combustion gases to adequately predict fuel consumption and specific thrust. A combustion thermochemistry routine was integrated into the engine cycle analysis routine to evaluate all hot gas properties. This approach accounts for gas species physical and chemical changes during the expansion process on equilibrium, frozen or partially frozen basis as appropriate. SFC error using heating value and conventional cycle analysis programs as great as 25 percent were observed. Specific thrust errors were as great as 10 percent.

Author

A85-19616#

AIRCRAFT TURBOJET ENGINE MODELING USING ARTIFICIAL INTELLIGENCE TECHNIQUES

R. RAJAGOPALAN (IBM Corp., Federal Systems Div., Houston, TX) and S. SIDDIQI (Embry-Riddle Aeronautical University, Daytona Beach, FL) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 14 p. refs

(AIAA PAPER 85-0253)

An attempt is made to demonstrate the feasibility of qualitatively modeling the operation of a turbojet engine. This falls under the area of qualitative reasoning in the field of artificial intelligence. The engine is qualitatively represented as a causal model consisting of pairs of operationally related engine parameters such as rpm, pressure ratio, etc. The computer simulation models the change from a given steady-state engine operation point due to changes in engine input parameters such as airspeed, fuel flow, etc. The simulation propagates only the sign of the derivative, not the quantity of the parameter. This is done using list-processing techniques developed in artificial intelligence. At the conclusion of the simulation, it is possible to predict whether there is an increase or decrease in thrust due to input change. The resulting state of the engine is checked to determine whether any operational limits may possibly have been exceeded. The model also possesses the capability to explain the results of the simulation, thus providing a training tool for engine operators. Author

A85-19671#

SFRJ SIMULATOR RESULTS - EXPERIMENT AND ANALYSIS IN COLD FLOW

J. RICHARDSON, W. A. DEGROOT, J. I. JAGODA, R. E. WALTERICK, J. E. HUBBARTT, and W. C. STRAHLE (Georgia Institute of Technology, Atlanta, GA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 8 p. refs

(Contract AF-AFOSR-83-0356)

(AIAA PAPER 85-0329)

This paper presents laser based experimental results and analytical results on two-dimensional backward facing step flows with mass injection from the bottom wall behind the step. The facility simulates the flowfield in the flame stabilization region of a solid fueled ramjet. Measured are two components of velocity and shear stress with and without secondary air injection. The same quantities are calculated for foreign gas injection. The most notable effect of blowing, both experimentally and analytically, is the appearance of a second recirculation zone. Analytically and experimentally, it is found that the general size of the main recirculatory region diminishes with increased blowing rate, and blowoff of the recirculation zone can occur at relatively low blowing rates. This indicates that flame stabilization may be strongly affected by the actual blowing rate in an SFRJ. Author

A85-19710#

BENEFITS AND COSTS OF POWERED ENGINE SIMULATION AT LOW SPEEDS

W. BURGSMELLER and J. SZODRUCH (Messerschmitt-Boelkow-Blohm GmbH, Bremen, West Germany) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 7 p. Research supported by the Bundesministerium fuer Forschung und Technologie. refs

(AIAA PAPER 85-0381)

The applications and benefits of using a turbo-powered simulator (TPS) for studying low speed, one-engine-out flight are discussed. The TPS technique can be employed in a wind tunnel to examine conditions where jet interference effects are important. Comparisons may be made between predictions and experimental data on the mixing of the primary and secondary jets in the engine wake and the flow over the wing. The TPS method costs 75 percent more to perform than through flow nacelle tests. However, if a one percent drag reduction is obtained, then the TPS tests are paid back 2.5 times due to the high resolution of the data on

drag increments. Likewise, a one percent hike in the mean take-off weight would return the TPS costs 3.5 times. M.S.K.

A85-19801*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

PREDICTED PERFORMANCE BENEFITS OF AN ADAPTIVE DIGITAL ENGINE CONTROL SYSTEM ON AN F-15 AIRPLANE

F. W. BURCHAM, JR., L. P. MYERS, and R. J. RAY (NASA, Ames Research Center, Flight Research Facility, Edwards, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 9 p. refs

(AIAA PAPER 85-0255)

The highly integrated digital electronic control (HIDEC) program will demonstrate and evaluate the improvements in performance and mission effectiveness that result from integrating engine-airframe control systems. Currently this is accomplished on the NASA Ames Research Center's F-15 airplane. The two control modes used to implement the systems are an integrated flightpath management mode and an integrated adaptive engine control system (ADECS) mode. The ADECS mode is a highly integrated mode in which the airplane flight conditions, the resulting inlet distortion, and the available engine stall margin are continually computed. The excess stall margin is traded for thrust. The predicted increase in engine performance due to the ADECS mode is presented in this report. Author

A85-19877

MICROPROCESSOR CONTROL OF TURBOPROP ENGINES [RIZENI TURBOVRTULOVEHO MOTORU MIKROPROCESOROVYM REGULATOREM]

J. MUELLER Zpravodaj VZLU (ISSN 0044-5355), no. 4, 1984, p. 219-231. In Czech.

Results of tests conducted on a microprocessor controller for a turboprop engine are reported. The objective of the tests was to evaluate the potential of microprocessor control and to develop a basis for future design work. Results of the tests confirm that digital electronics provides an efficient means of engine control, with functional reliability remaining the principal problem. V.L.

A85-20060

ARMY, NASA RESEARCHING NEEDS FOR FUTURE ENGINE COMPONENTS

Aviation Week and Space Technology (ISSN 0005-2175), vol. 122, Jan. 14, 1985, p. 99, 103, 104.

Attention is given to the most promising alternatives under consideration in helicopter powerplant research programs being conducted by the U.S. Army's Aviation Systems Command and NASA. Basic engine designs under consideration are compound turbine-diesels and regenerative and recuperative cycle gas turbines. Component technology research is primarily concerned with high temperature materials, such as ceramics, and with variable area features for engine diffusers, nozzles, and inlet guide vanes. The compound turbine-diesel technology, although comparatively immature, promises very low specific fuel consumption, excellent partial power fuel economy, and lower exhaust temperatures, which minimize IR emissions in military helicopters. O.C.

A85-20061

EUROPEANS USING COMPOSITES, CERAMICS FOR ROTORCRAFT ENGINE IMPROVEMENTS

Aviation Week and Space Technology (ISSN 0005-2175), vol. 122, Jan. 14, 1985, p. 105-107, 110, 115.

An evaluation is made of French, West German, and British helicopter engine technology development trends. Typical of current efforts is the West German GNT 1 new technology gas generator for engines in the 1400-shp power class, which features a highly loaded, combined axial-centrifugal compressor, a reverse flow combustion chamber and a single stage transonic, cooled, compressor-driving turbine stage employing powder metallurgy-fabricated disks. Ceramic bearings are noted to be under investigation in both West Germany and Britain. In France, attention is being given to new materials for use in small turboshaft engines which will allow both higher operating temperatures and lower

07 AIRCRAFT PROPULSION AND POWER

production costs; ceramic components and coatings in engine hot sections are again prominent in these development programs.

O.C.

A85-20235#

SOME IMPROVEMENTS ON AN ANNULAR COMBUSTOR OF AI TYPE TURBOJET ENGINE

B. ZHANG, Y. HOU, and D. HUANG (Shenyang Aeroengine Co., Shenyang, People's Republic of China) *Journal of Engineering Thermophysics*, vol. 5, Feb. 1984, p. 91-93. In Chinese, with abstract in English.

A85-20242#

DETERMINATION OF SURGING LINE OF TWO-SPOOL AXIAL FLOW COMPRESSOR WITH CROPPED FAN STAGES AT LOW SPEED BY USE OF PARALLEL COMPRESSOR THEORY

F. ZHONG and Z. LU (Jiaotong University, Shanghai, People's Republic of China) *Journal of Engineering Thermophysics*, vol. 5, May 1984, p. 157-159. In Chinese, with abstract in English.

A85-20243#

EXPERIMENTAL INVESTIGATION OF BACKSWEEP CENTRIFUGAL COMPRESSOR IMPELLER. I

Z. DIAO, J. CHEN, X. CAO, Y. YU, E. WANG, and M. PANG (Chinese Academy of Sciences, Institute of Engineering Thermophysics, Beijing, People's Republic of China) *Journal of Engineering Thermophysics*, vol. 5, May 1984, p. 160-163. In Chinese, with abstract in English. refs

Tests of an impeller with 25-deg backswEEP were conducted to establish stage and impeller characteristics. Tip speed of 380 m/sec was attained. Compared with a radial-discharge impeller which has the same diameter and inducer-blade profile, the stage efficiency was increased by 4 percent, and the operating range was improved significantly. The effect of reaction on the stage performance is analyzed. Test data on the slip factor and the energy-transfer coefficient are given. Author

A85-20822

MODERN MILITARY ENGINES. II

M. HIRST *Air International* (ISSN 0306-5634), vol. 28, Jan. 1985, p. 24-30.

A discussion is conducted concerning the design features and performance characteristics of state-of-the-art turbojets and turbofans for advanced military aircraft such as the Mirage 2000, B-1B, Tornado, and AMX. Attention is given to the progressive reduction of engine size and weight for a given thrust output over the last 30 years, as evidenced by the equivalent thrust J-79 (old) and F-404 (new). Similar advances are noted for specific fuel consumption reduction. The development histories that are related trace the genealogies of several engines, answering requirements that differ widely with respect to total thrust and mission profile, from a single 'gas generator' core, as in the case of the F-101 bomber engine and its F-110 fighter engine derivative. O.C.

A85-20867*# Texas A&M Univ., College Station.

ANALYTICAL DETERMINATION OF PROPELLER PERFORMANCE DEGRADATION DUE TO ICE ACCRETION

T. L. MILLER (Sverdrup Technology, Inc., Middleburg Heights, OH), K. D. KORKAN (Texas A&M University, College Station, TX), and R. J. SHAW (NASA, Lewis Research Center, Cleveland, OH) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 42 p. refs (Contract NAG3-242) (AIAA PAPER 85-0339)

It is pointed out that ice accretion on aircraft produces an adverse effect on aircraft performance in terms of decreased lift and increased drag of the lifting surface. Ice on the surface of a propeller may also cause a decrease in thrust, increase in the required power, and a resultant decrease in propeller efficiency. During the past years, a number of attempts have been made to analyze the effects of ice accretion on both fixed wings and propellers. The present investigation is concerned with the development of a single user-oriented computer code which makes

it possible to calculate propeller performance degradation due to ice accretion for specified flight conditions, atmospheric conditions, and propeller geometry. This development is based on a combination of several of the codes and correlations considered in earlier studies. G.R.

A85-21420

AERONAUTICAL GAS TURBINES. III [LES TURBINES A GAZ AERONAUTIQUES. III]

Air et Cosmos (ISSN 0044-6971), vol. 22, Dec. 22, 1984, p. 19, 43. In French.

The performance levels and applications of the family of gas turbine engines manufactured by Pratt-Whitney are surveyed. The company has built about 62,000 engines since 1948, 2/3 having been used on military aircraft. The newest series, the JT9D-7R4, has achieved 1,000,000 flight hours, powers the 767-200, 747-300, A 310-200, and the A 300-600, and will be installed on the A 310-300. The engine delivers 48,000-56,000 lb. thrust and has featured a MTBF of 40,000 hr. The new PW2000 and PW4000 families of engines feature single-crystal blades and high rpm operation. PW is also participating in development of the 21,000-23,000 lb. thrust V2500 engine for near term transport aircraft. The F100 engine is used in the F15 and F16 fighters and is being upgraded. The PW1120 is being flight tested as a replacement engine for all F-4 engines. Three other engines, including the PW3005 for the JYX, are under development. M.S.K.

A85-21466#

TRENDS IN DIGITAL ENGINE CONTROL - INTEGRATION OF PROPULSION CONTROL WITH FLIGHT CONTROL AND AVIONIC SYSTEMS IN FUTURE MILITARY AND COMMERCIAL AIRCRAFT

E. S. ECCLES (Dowty & Smith Industries Controls Ltd., Cheltenham, Glos., England) IN: Design and advanced concepts of avionics/weapons system integration; Proceedings of the Symposium, London, England, April 3, 4, 1984. London, Royal Aeronautical Society, 1984, 9 p. Research supported by the Ministry of Defence of England. refs

This paper discusses future trends in engine control and addresses the integration of flight control and propulsion control both in commercial and in future advanced military aircraft. Such aircraft may employ sustained supersonic cruise and maneuvering flight, thrust vectoring and extensive variable geometry features. The paper outlines the factors which force the integration of systems, the benefits hoped for and the status of current work. It discusses the effects of integration on inter-system and inter-organizational interfaces and the methods and technologies needed to achieve the ends being sought within anticipated timescales. Author

A85-21682

PREDICTION OF PERFORMANCE OF AIRCRAFT GAS TURBINES

L. L. DUNCKER Aeronautical Society of South Africa and South African Institute of Aeronautical Engineers, *Journal* (ISSN 0250-3786), vol. 5, no. 1, 1984, p. 46-51.

Attention is given to the means by which one can predict the steady state off-design performance of a single spool turbojet engine, using a computer simulation model. The performance characteristics of the individual components over a range of off-design conditions are generated through computerized analytical approaches, and can be verified by performing actual component tests. Components are linked together in such a way as to satisfy compatibility requirements. The determination of corresponding operating points on each component characteristic when the engine is running in equilibrium, at a specific off-design condition, is followed by consideration of equilibrium running lines and their change with flight altitude and Mach number. O.C.

A85-21839#

FLOWFIELD ANALYSIS OF LOW BYPASS RATIO TEST CELLS
S. L. KROMER and D. A. DIETRICH (General Electric Co., Cincinnati, OH) Journal of Aircraft (ISSN 0021-8669), vol. 22, Feb. 1985, p. 99, 100. Abridged. Previously cited in Issue 06, p. 723, Accession no. A84-17999.

A85-21866*# Pennsylvania State Univ., University Park.

EFFECTS OF FRICTION DAMPERS ON AERODYNAMICALLY UNSTABLE ROTOR STAGES

A. SINHA (Pennsylvania State University, University Park, PA) and J. H. GRIFFIN (Carnegie-Mellon University, Pittsburgh, PA) AIAA Journal (ISSN 0001-1452), vol. 23, Feb. 1985, p. 262-270. Previously cited in issue 14, p. 1976, Accession no. A83-32791. refs
(Contract NAG3-231)

A85-22231#

INFLUENCE OF BLOWING RATE AND INJECTION ANGLE ON THE PERFORMANCE OF A FILM-COOLED BLADE

G. N. RAO (Siddhartha Engineering College, Vijayawada, India) and W. V. NABAR (Indian Institute of Technology, Bombay, India) Aeronautical Society of India, Journal (ISSN 0001-9267), vol. 36, May 1984, p. 129-135. refs

The effect of blowing rate and coolant injection angle on the efficiency of film-cooling of a turbine blade is studied experimentally, for constant values of the mainstream turbulence intensity, inlet Reynolds number, and the geometry and dimensions of the injection holes. Three rows of coolant-injection holes were cut on both sides of the blade. Coolant was injected at 30, 45, 90, and 30 x 45 (compound) degrees at blowing rates from 0.1 to 2.0. It is shown that the optimal value of the blowing rate, at which the cooling is most efficient, increases with the downstream distance, at a significantly higher rate of increase for the 45 and 30 x 45-degree injection angles. Surface curvature is also suggested to play an important role in cooling efficiency. L.T.

N85-15723 Department of the Air Force, Washington, D.C.

MOUNTING CONSTRUCTION FOR TURBINE VANE ASSEMBLY Patent

D. S. WOLF, inventor (to Air Force) 16 Oct. 1984 4 p Supersedes AD-D009948

(AD-D011395; US-PATENT-4,477,222;

US-PATENT-APPL-SN-431435; US-PATENT-CLASS-415-138)

Avail: US Patent and Trademark Office CSCL 21E

A turbine vane assembly of a gas turbine engine includes inner and outer shroud walls and a plurality of airfoil-shaped vanes extending between and connected at their opposite ends with the inner and outer shroud walls. The mounting construction of the vane ends to the respective shroud walls includes a plurality of recessed ledges defined in the shroud walls along respective ones of the ends of the vanes. Each ledge forms a gap between the respective wall and vane end extending from a trailing edge pressure side of the vane along the pressure side to a location approximately midway between the trailing and leading edges of the vane. The remainder of the vane end is rigidly connected to the respective shroud wall. Author (GRA)

N85-15724*# Tuskegee Inst., Ala. School of Engineering and Architecture.

AN IMPROVED COMPUTER MODEL FOR PREDICTION OF AXIAL GAS TURBINE PERFORMANCE LOSSES Final Report

R. M. JENKINS Aug. 1984 119 p refs

(Contract NSG-3295)

(NASA-CR-174246; NAS 1.26:174246) Avail: NTIS HC A03/MF A01 CSCL 21E

The calculation model performs a rapid preliminary pitchline optimization of axial gas turbine annular flowpath geometry, as well as an initial estimate of blade profile shapes, given only a minimum of thermodynamic cycle requirements. No geometric parameters need be specified. The following preliminary design data are determined: (1) the optimum flowpath geometry, within mechanical stress limits; (2) initial estimates of cascade blade

shapes; and (3) predictions of expected turbine performance. The model uses an inverse calculation technique whereby blade profiles are generated by designing channels to yield a specified velocity distribution on the two walls. Velocity distributions are then used to calculate the cascade loss parameters. Calculated blade shapes are used primarily to determine whether the assumed velocity loadings are physically realistic. Model verification is accomplished by comparison of predicted turbine geometry and performance with an array of seven NASA single-stage axial gas turbine configurations. B.W.

N85-15725*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

EFFECT OF STEADY-STATE TEMPERATURE DISTORTION ON INLET FLOW TO A HIGH-BYPASS-RATIO TURBOFAN ENGINE

R. H. SOEDER, C. M. MEHALIC, and K. STANCIK (AFSC) Jan. 1985 32 p refs

(NASA-TM-86896; E-2369; NAS 1.15:86896) Avail: NTIS HC A03/MF A01 CSCL 21E

The effects of circumferential inlet temperature distortion on the flow characteristics between a distortion generator and a high bypass ratio turbofan engine and through its compression system were evaluated to support the effort to generate analytical models. The flow characteristics are defined by the inlet duct, the flow angles, and the total temperature, total pressure, and static pressure profiles in the inlet duct and through the fan and compressor. The effects of Reynolds number, rotor speed, and distortion extent are also considered. E.A.K.

N85-15729*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, Calif.

PREDICTED PERFORMANCE BENEFITS OF AN ADAPTIVE DIGITAL ENGINE CONTROL SYSTEM OF AN F-15 AIRPLANE Final Report

F. W. BURCHAM, JR., L. P. MYERS, and R. J. RAY Jan. 1985 11 p refs Prepared in cooperation with NASA, Ames Research Center

(NASA-TM-85916; H-1269; NAS 1.15:85916) Avail: NTIS HC A02/MF A01 CSCL 21E

The highly integrated digital electronic control (HIDEC) program will demonstrate and evaluate the improvements in performance and mission effectiveness that result from integrating engine-airframe control systems. Currently this is accomplished on the NASA Ames Research Center's F-15 airplane. The two control modes used to implement the systems are an integrated flightpath management mode and an integrated adaptive engine control system (ADECS) mode. The ADECS mode is a highly integrated mode in which the airplane flight conditions, the resulting inlet distortion, and the available engine stall margin are continually computed. The excess stall margin is traded for thrust. The predicted increase in engine performance due to the ADECS mode is presented in this report. Author

N85-15731# Pratt and Whitney Aircraft, West Palm Beach, Fla. Government Products Div.

IMPROVEMENT OF THE CORROSION RESISTANCE OF TURBINE ENGINE BEARINGS Interim Report, Aug. 1981 - Jul. 1983

J. H. MOHN, H. M. HODGENS, II, H. E. MUNSON (TRW, Inc., Jamestown, N.Y.), and W. E. POOLE Wright-Patterson AFB, Ohio AFWAL Feb. 1984 165 p Original contains color illustrations

(Contract F33615-81-C-2023)

(AD-A147430; PWA/GPD/FR-17952; AFWAL-TR-84-2014) Avail: NTIS HC A08/MF A01 CSCL 21E

This technical report encompasses the work accomplished in the first phase of a two-phase program aimed at developing an alternate material, fabrication technique, or material treatment for turbine engine mainshaft bearings with improved corrosion resistance compared to state of the art VIM-VAR M50. During Phase 1, five corrosion-resistant bearing candidates (armoloy-coated M50, nickel sputter-coated M50, wrought CRB7,

RSR565 and MRC2001) identified as the most promising were subjected to rolling contact fatigue, corrosion, hot hardness and wear screening tests. The phase concluded with selection of MCR2001 as the single most promising candidate for full-scale bearing fabrication and testing. In Phase 2 that candidate will be subjected to further full-scale bearing life and performance tests and a corrosion-resistant verification test. Author (GRA)

N85-15732# Naval Postgraduate School, Monterey, Calif.
CONTROL SYSTEM DESIGN LANGUAGE IMPLEMENTATION OF A GAS TURBINE STARTING CONTROLLER M.S. Thesis
 R. P. RILEY Jun. 1984 124 p
 (AD-A147896) Avail: NTIS HC A06/MF A01 CSCL 09B

This thesis investigates the feasibility and utility of the Computer System Design Language (CSDL) and its design environment. The primary purpose of this design system is to automatically design microprocessor-based controller prototypes given a description of the controller's behavior. CSDL is used to create a highly structured behavioral description which is used by the design environment to create a software and hardware listing. A generic gas turbine engine start malfunction controller is developed using CSDL and tested on a Prolog development system. GRA

N85-15733# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).
ENGINE CYCLIC DURABILITY BY ANALYSIS AND TESTING
 Loughton, England Sep. 1984 271 p refs In ENGLISH and FRENCH Conf. held in Lisse, Netherlands, 30 May - 1 Jun. 1984
 (AGARD-CP-368; ISBN-92-835-0362-7) Avail: NTIS HC A12/MF A01

Engine utilization and accelerated mission testing development; critical material characterization; life assessment methodologies; and component and engine cyclic testing are discussed. The current state-of-the-art in technological areas is related to improving engine life. The technical and economical problems of advanced cyclic testing in the development of engines are considered with focus on relationships between engine utilization and failure modes, accelerated mission testing development, critical material characteristics, component life assessment methods, recent results of component and engine cyclic testing, and future requirements.

N85-15735# Rolls-Royce Ltd., Bristol (England).
MONITORING ENGINE THERMAL STRESSES
 T. M. EDMUNDS and R. A. LAWRENCE In AGARD Eng. Cyclic Durability by Analysis and Testing 20 p Sep. 1984 refs
 Avail: NTIS HC A12/MF A01

The high performance and rapid response of modern military engines means that transient thermal stresses make a significant contribution to the fatigue life utilization of critical rotating components. This, coupled with the variability of actual usage, raises a requirement for calculating transient thermal stresses from flight recorded data. A computationally efficient procedure for meeting this requirement is described. The analysis is based on a simplified model of the heat transfer and mechanics of the engine that is tuned with results of more sophisticated finite difference and finite element computations. Applications to an engine disc are described using data collected by on-board recordings. The results are validated by comparisons with more detailed theoretical analyses - practical constraints preventing a direct measurement of in-flight stresses. The integration of the results into the overall lifting procedure is also briefly described. Author

N85-15736# Aeronautical Systems Div., Wright-Patterson AFB, Ohio.
ACCELERATED MISSION ENDURANCE TESTING (AMET)
 W. R. TAYLOR In AGARD Eng. Cyclic Durability by Analysis and Testing 5 p Sep. 1984 refs
 Avail: NTIS HC A12/MF A01

The cost of ownership of gas turbine aircraft engines today makes it imperative that the development process produce a production engine that will minimize life cycle cost. This problem was recognized and one of the most significant changes that was

made in the last 10 years is the incorporation of AMET into the development programs. In the past, engine designs were qualified for production release when it successfully completed a 150 hour model test. However, as these engines accumulated service time, problems arose that were not discovered in factory test. It was apparent that the durability of these engines were not well understood. In 1973, the US Air Force, Navy, and Detroit Diesel Allison incorporated a new test cycle in their TF41 engine development program that was representative of the aircraft usage. The success of this effort encouraged the incorporation test method into other engine development programs. Today, the US Air Force uses factory test cycles for design verification and qualification that were derived from known or projected aircraft usages. The background of mission related testing, test cycle derivation, data sources, key parameters, limitations and benefits will be discussed. Author

N85-15737# Turbomeca S. A. - Brevets Szydlowski, Bordes (France).
DESIGN AND TEST REQUIREMENTS FOR DEVELOPMENT OF TODAY'S ENGINES [EXIGENCES DE CONCEPTION ET D'ESSAI POUR DEVELOPPER LES MOTEURS D'AUJOURD'HUI]
 J. FRESCO In AGARD Eng. Cyclic Durability by Analysis and Testing 14 p Sep. 1984 In FRENCH Original language doc. previously announced as N82-17205
 Avail: NTIS HC A12/MF A01

To adapt to the ever greater safety and profitability requirements for transport aircraft, the engine must fulfill two functions which are often of an opposite nature: performance and durability. The combination of these two lines of force: performance (translated in terms of fuel consumption or power) and durability, lead to the final objective which is cost reduction. Today, from the beginning of a new engine, it is necessary to quarantine potentials that are of the same order, if not superior, to those of engines which have already accumulated thousands of flight hours. The different methods that permit achieving the durability objective are analyzed including how they are involved in engine design. Tests which best reproduce the damage phenomena are described, and some examples are given which relate particularly to small engines.

Transl. by A.R.H.

N85-15738# National Aerospace Lab., Amsterdam (Netherlands).
OVERVIEW OF THE AGARD SMP ACTIVITIES ON TURBINE ENGINE MATERIALS TECHNOLOGY IN THE 1972 - 1982 PERIOD

A. J. A. MOM In AGARD Eng. Cyclic Durability by Analysis and Testing 34 p Sep. 1984 refs
 Avail: NTIS HC A12/MF A01

An overview of research on turbine engine technology over the last 10 years is given. These activities cover most of the material related aspects in gas turbine technology from the initial design stage up to the final retirement of components. The development and application of advanced materials; material properties and behavior; material processing and fabrication techniques; maintenance and repair; and life prediction methods are discussed. With respect to the advanced materials and fabrication techniques, attention is given to the directionally solidified in-situ composites, the ceramic materials and the powder metallurgy materials, and their different processing aspects. New fabrication techniques like hot isostatic pressing, superplastic forming and surface treatments are included. Furthermore the corrosion behavior and low cycle fatigue characteristics of engine materials, including methods to predict creep and fatigue behavior, e.g., the strain range partitioning method, are discussed. Finally, attention is given to maintenance, repair and life prediction of engine components. Emphasis is directed to the introduction of damage tolerance concepts to make a more economic use of inherently available component life than is presently done by the safe life philosophy. R.J.F.

N85-15741# Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio.

CUMULATIVE DAMAGE MODELING OF FATIGUE CRACK GROWTH

J. M. LARSEN and T. NICHOLAS *In* AGARD Eng. Cyclic Durability by Analysis and Testing 15 p Sep. 1984 refs

Avail: NTIS HC A12/MF A01

Life predictions of turbine engine structural components utilize fracture mechanics principles to determine fatigue crack growth rates. Fatigue cracks grow under conditions of variable temperature, frequency, hold time, stress ratio, and stress level. At elevated temperatures, time dependent material behavior can play a significant role in the material behavior. Cumulative damage models must account for all these variables as well as interaction effects. The earliest modeling involved interaction schemes, and, primarily, time independent material behavior. More recent work focused on time dependence and creep fatigue interaction effects. A review of current modeling concepts and problems is presented. R.J.F.

N85-15742# National Aeronautical Establishment, Ottawa (Ontario). Structures and Materials Lab.

PROBLEMS AND POSSIBILITIES FOR LIFE EXTENSION IN GAS TURBINE COMPONENTS

A. K. KOUL, W. WALLACE, and R. THAMBURAJ (Carleton Univ., Ottawa) *In* AGARD Eng. Cyclic Durability by Analysis and Testing 32 p Sep. 1984 refs

Avail: NTIS HC A12/MF A01

Data showing the beneficial effects of hot isostatic processing on the stress rupture properties of new and service exposed Ni based superalloy turbine blades are presented. Creep design methods that are generally used to highlight the service induced degeneration effects are critically analyzed. A new life prediction method that systematically analyzes the creep degeneration effects with increasing service life is proposed. Results indicating the successful application of a damage tolerance based maintenance methodology in Canadian Forces J85 engine compressor and turbine discs are discussed. Possibilities of enhancing engine component durability through improved machining techniques and reheat treatments are also discussed. Author

N85-15743# Royal Aircraft Establishment, Farnborough (England). Materials and Engineering Research Div.

DISC FATIGUE LIFE PREDICTIONS FOR GAS TURBINE ENGINES

W. J. EVANS, M. E. F. SMITH, and C. H. H. WILLIAMS *In* AGARD Eng. Cyclic Durability by Analysis and Testing 13 p Sep. 1984 refs

Avail: NTIS HC A12/MF A01

Safe cyclic lives for discs in gas turbine engines were determined. The current procedures which are based on a life-to-first-crack philosophy and, in Britain, require full scale component testing to establish a service safe life are reviewed. The limitations of this approach are highlighted. It is then suggested that an alternative method based on fatigue crack propagation should overcome some of the limitations. Before this alternative can be adopted, however, it is important to develop quantitative models for the types of crack that occur in engine discs. These cracks tend to be embedded, situated at stress concentration features and subjected to multiaxial stress fields. Some of the published work on such cracks is reviewed and the more relevant models detailed. An experimental program on the titanium alloy Ti-6-4 is then described in which the behavior of small cracks is evaluated for stress concentration features in bend specimens and model discs. R.S.F.

N85-15744*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

ENGINE CYCLIC DURABILITY BY ANALYSIS AND MATERIAL TESTING

A. KAUFMAN and G. R. HALFORD *In* AGARD Eng. Cyclic Durability by Analysis and Testing 12 p Sep. 1984 refs

Previously announced as N84-18683

Avail: NTIS HC A12/MF A01 CSCL 21E

The problem of calculating turbine engine component durability is addressed. Nonlinear, finite-element structural analyses, cyclic constitutive behavior models, and an advanced creep-fatigue life prediction method called strainrange partitioning were assessed for their applicability to the solution of durability problems in hot-section components of gas turbine engines. Three different component or subcomponent geometries are examined: a stress concentration in a turbine disk; a louver lip of a half-scale combustor liner; and a squealer tip of a first-stage high-pressure turbine blade. Cyclic structural analyses were performed for all three problems. The computed strain-temperature histories at the critical locations of the combustor liner and turbine blade components were imposed on smooth specimens in uniaxial, strain-controlled, thermomechanical fatigue tests of evaluate the structural and life analysis methods. Author

N85-15745# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).

LIFE PREDICTION AT HIGH TEMPERATURE UNDER MULTIAXIAL LOADING

G. GAILLETAUD and J. L. CHABOCHE *In* AGARD Eng. Cyclic Durability by Analysis and Testing Sep. 1984 refs

Avail: NTIS HC A12/MF A01

The activities of ONERA concerning the life prediction of high temperature components are summarized. In the last few years, the viscoplastic finite element computer code EVPCYCL was developed which is suitable for any two-dimensional problem (plane stress or strain, axisymmetrical case). The code's main specificity is the choice of various possibilities concerning the constitutive equations: cyclic calculations can be made with kinematic and isotropic hardening, with the introduction of a memory effect, etc. Graphic post-processors are available as well as a life prediction program that takes into account creep and fatigue damage. Author

N85-15751# Pratt and Whitney Aircraft Group, West Palm Beach, Fla. Engineering Div.

VIEW OF FUTURE REQUIREMENTS FOR ENGINE CYCLIC DURABILITY BY ANALYSIS AND TESTING

T. E. FARMER *In* AGARD Eng. Cyclic Durability by Analysis and Testing 6 p Sep. 1984 refs

Avail: NTIS HC A12/MF A01

Future requirements of engine cyclic durability analysis and testing. These requirements must satisfy advancements in technology and configuration in a cost-effective manner. The importance are discussed of demonstrating engine durability is emphasized. It is essential that an integrated approach to durability verification be developed and involve component durability analysis, engine measured parameters, laboratory test and engine demonstrated capabilities. Automated analysis techniques must confidently relate test conditions to field operation; non-interference sensors and enhanced data acquisition systems are required for extended test periods; and engine testing must efficiently address sensitivities, operating limits and cyclic capabilities. Verified component durability prediction systems that are developed can reduce the number of required engine endurance tests. Through coordination of durability analysis, data acquisition and component demonstration testing, more complete knowledge of engine durability will be achieved in a cost-effective manner. B.W.

07 AIRCRAFT PROPULSION AND POWER

N85-16873* Massachusetts Inst. of Tech., Cambridge. Lab. for Information and Decision Systems.

MULTIVARIABLE FLIGHT CONTROL WITH TIME-SCALE SEPARATION

K. HAIGES May 1984 144 p refs

(Contract NGL-22-009-124)

(NASA-CR-174320; NAS 1.26:174320; LIDS-TH-1381) Avail:

NTIS HC A07/MF A01 CSCL 20E

The design of a compensator to provide a multivariable closed-loop, feedback control system with bandwidth separated input-output groups is considered. The basic contribution is to analyze, improve, and illustrate the programmatically used closed-one-loop at-a-time design procedure and to investigate the attainable performance and robustness properties. The design example used is the AV-8A Harrier aircraft. The underlying philosophy employed in the Linear Quadratic Gaussian with Loop Transfer Recovery (LOG/LTR) design methodology. Author

N85-16874# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Systems and Logistics.

THE APPLICATION OF A TECHNOLOGY INDEX TO AIRCRAFT TURBINE ENGINE COST ESTIMATING RELATIONSHIPS M.S. Thesis

W. P. SIMPSON, III and J. R. SIMS, JR. Sep. 1984 102 p

(AD-A147701; AFIT/GSM/LSY/84S-25) Avail: NTIS HC

A06/MF A01 CSCL 14A

This research attempts to develop a technological index based on selected characteristics of new products. The methodology employed to develop the index was adopted from the technological forecasting community, where it is accepted as a valid technique for quantifying technological change. Several indices were developed to measure the level of technology incorporated into the design and development of aircraft turbine engines. Each index was based on a different assumption about the expected time path of technological growth. The data set was restricted to the same engines used by Rand to develop a set of cost estimating relationships (CERs) for estimating the development cost to model qualification tests, production cost, and the total development cost of jet engines. Selected indices were then introduced into the Rand CERs to evaluate their impact as cost drivers and their relationship to the other variables in the equations. The application resulted in the technology indices being significant and valid cost drivers. GRA

N85-16875# Rolls-Royce Ltd., Derby (England).

THE AIRCRAFT ENGINE OF THE FUTURE

J. F. COPLIN 10 Sep. 1984 37 p Presented at British Assoc.

for the Adv. of Sci., Norwick, England 10-14 Sep. 1984

(PNR-90226) Avail: NTIS HC A03/MF A01

Quieter, simpler, and more efficient aircraft engines designed using computers, and built in automated factories, are predicted. Ceramic blades and mixed flow compressors are discussed.

Author (ESA)

08

AIRCRAFT STABILITY AND CONTROL

Includes aircraft handling qualities; piloting; flight controls; and autopilots.

A85-19498#

A LONGITUDINAL STABILITY AUGMENTATION SYSTEM FOR A TILT ROTOR AIRCRAFT

C. DABUNDO and M. D. NEARY (Drexel University, Philadelphia, PA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 10 p. refs (AIAA PAPER 85-0072)

The Army/NASA/Bell XV-15 is a twin engine, tilt-rotor aircraft that combines the VTOL capability of the helicopter with the cruise

capability of a fixed wing aircraft. The tilt-rotor's unique use of helicopter rotors as opposed to fixed props allows for unconventional control stabilization in forward flight. The success of the tilt-rotor is directly related to its cost effectiveness, which can be improved by increasing its efficiency and payload capacity. The efficiency and payload capacity of the tilt-rotor can be increased by reducing the area of the horizontal stabilator which in effect reduces drag and weight. Drag can be further reduced by decreasing the aircraft's static margin. Unfortunately, these configuration changes render the aircraft's longitudinal dynamics unstable, and thus create a need for a longitudinal stability augmentation system. An iterative process is developed in which the aircraft and control system parameters are varied to yield an optimum configuration which maximizes efficiency and payload capacity while retaining acceptable flying qualities. Author

A85-19583*# Kansas Univ., Lawrence.

THEORY OF WING ROCK

C.-H. HSU and C. E. LAN (Kansas, University, Lawrence, KS)

American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 8 p. refs

(Contract NAG1-134)

(AIAA PAPER 85-0199)

Wing rock is one type of lateral-directional instabilities at high angles of attack. To predict wing rock characteristics and to design airplanes to avoid wing rock, parameters affecting wing rock characteristics must be known. A new nonlinear aerodynamic model is developed to investigate the main aerodynamic nonlinearities causing wing rock. In the present theory, the Beecham-Titchener asymptotic method is used to derive expressions for the limit-cycle amplitude and frequency of wing rock from nonlinear flight dynamics equations. The resulting expressions are capable of explaining the existence of wing rock for all types of aircraft. Wing rock is developed by negative or weakly positive roll damping, and sustained by nonlinear aerodynamic roll damping. Good agreement between theoretical and experimental results is obtained. Author

A85-19585*# Waterloo Univ. (Ontario).

TRANSIENT MOTION OF HYPERSONIC VEHICLES INCLUDING TIME HISTORY EFFECTS

W. H. HUI (Waterloo, University, Waterloo, Ontario, Canada) and

H. J. VAN ROESSEL American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 10 p. refs

(Contract NAGW-575)

(AIAA PAPER 85-0201)

An analytic method is developed for calculating the transient pitching motion of a wedge in hypersonic flow, taking into account fully the interaction between its motion and the unsteady air flow passing it. The effects of past motion history on the present state of motion are shown to be caused by the wave reflection from the bow shock. In the Newtonian limit they are equivalent to that of an added moment of inertia. The time history effects generally tend to decrease the damping, rendering the oscillatory motion more persistent. Numerical examples are given. Author

A85-19656*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

DESIGNING A PRIORITY DRIVEN MULTI-FRAME RATE FLIGHT EXECUTIVE

R. SMITH-TAYLOR (NASA, Langley Research Center, Analysis and Computation Div., Hampton, VA) American Institute of

Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 7 p. refs

(AIAA PAPER 85-0309)

The Advanced Transport Operating System (ATOPS) project is a NASA operational research flight project which is concerned with upgrading the new generation of flight computers. In connection with this work, it becomes also necessary to reassess the adequacy of the flight executive and flight software. In the present discussion, attention is given to the ATOPS project upgrade, the operating flight system, the design criteria for the new flight executive, the implementation of the executive, a sample

real-time execution, a real-time debug and test tool, and several experiences which could be useful to others considering a similar exercise. G.R.

A85-19685* National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
HYPERSONIC CHARACTERISTICS OF AN ADVANCED AEROSPACE PLANE

R. S. MCCANDLESS and C. I. CRUZ (NASA, Langley Research Center, Space Systems Div., Hampton, VA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 9 p. refs (AIAA PAPER 85-0346)

A series of hypersonic wind-tunnel tests have been conducted in the NASA Langley Hypersonic Facilities Complex to obtain the static longitudinal and lateral-directional aerodynamic characteristics of an advanced aerospace plane. Data were obtained at 0 to 20 deg angles of attack and -3 to 3 deg angles of sideslip at Mach numbers of 6 and 10 in air and 20 in helium. Results show that stable trim capability exists at angles of attack near maximum lift-drag ratio (L/D). Both performance and stability exhibited some Mach number dependency. The vehicle was longitudinally unstable at low angles of attack but stable at angles of attack near and above maximum L/D. It was directionally unstable with positive dihedral effect. The rudder showed an inability to provide lateral-directional control, and removing the vertical tail resulted in increased directional instability. Analytical predictions of the static longitudinal aerodynamic coefficients gave relatively good comparisons with the experimental data. Author

A85-19828
INVESTIGATIONS FOR THE USE OF AN ACTIVE CONTROL IN AIRCRAFT [UNTERSUCHUNGEN ZUM EINSATZ EINES AKTIVEN BEDIENELEMENTS IM FLUGZEUG]

H. GUENTHER Braunschweig, Technische Universitaet, Fakultae fuer Maschinenbau und Elektrotechnik, Dr.-Ing. Dissertation, 1984, 124 p. In German. refs

The design, simulation, and flight testing of active controls (ACs) for aircraft are reported and illustrated with drawings, photographs, graphs, block diagrams, and tables of results. The AC uses digitally determined continuous displacement of the stick zero point and proportional increases in stick resistance to give the pilot accurate kinesthetic information on the control error to be corrected. Comparative tests with trained pilots in a flight simulator show that an electrohydraulic system which permits switching from an active stick (which forces the pilot to adopt the strategy of a fully automatic flight-control system) to a passive stick (fly-by-wire pilot control without synthetic kinesthetic information) is effective in improving flight-path accuracy in complex approach maneuvers. These findings are confirmed by flight tests using an experimental installation in a Do-28 aircraft. T.K.

A85-19876
CALCULATION OF THE MINIMUM-TIME LOOP MANEUVER FOR JET AIRCRAFT [VYPOCET CASOVE NEJKRATSIHO PREMETS PROUDOVEHO LETOUNU]

J. KUDRNA Zpravodaj VZLU (ISSN 0044-5355), no. 4, 1984, p. 209-217. In Czech.

A mathematical model is presented which makes it possible to determine optimum changes of angle of attack and engine thrust with time resulting in a minimum-time loop maneuver that ends at a specified altitude or a specified speed. The loop maneuver time and the required lift coefficient and engine thrust can be specified at the design stage. In the general case, the optimum path of an aircraft is shown to consist of three different arcs; the optimum values of the control variables are functions of stage variables and Lagrange multipliers. V.L.

A85-20143* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

APPLICATION OF AN ADAPTIVE BLADE CONTROL ALGORITHM TO A GUST ALLEVIATION SYSTEM

S. SAITO (NASA, Ames Research Center, Moffett Field, CA) (European Rotorcraft and Powered Lift Aircraft Forum, 9th, Stresa, Italy, Sept. 13-15, 1983) Vertica (ISSN 0360-5450), vol. 8, no. 3, 1984, p. 289-307. Previously announced in STAR as N84-10079. refs

The feasibility of an adaptive control system designed to alleviate helicopter gust induced vibration was analytically investigated for an articulated rotor system. This control system is based on discrete optimal control theory, and is composed of a set of measurements (oscillatory hub forces and moments), an identification system using a Kalman filter, a control system based on the minimization of the quadratic performance function, and a simulation system of the helicopter rotor. The gust models are step and sinusoidal vertical gusts. Control inputs are selected at the gust frequency, subharmonic frequency, and superharmonic frequency, and are superimposed on the basic collective and cyclic control inputs. The response to be reduced is selected to be that at the gust frequency because this is the dominant response compared with sub- and superharmonics. Numerical calculations show that the adaptive blade pitch control algorithm satisfactorily alleviates the hub gust response. Almost 100 percent reduction of the perturbation thrust response to a step gust and more than 50 percent reduction to a sinusoidal gust are achieved in the numerical simulations. Author

A85-21465#
TRENDS IN DIGITAL FLIGHT CONTROL SYSTEMS

K. W. ROSENBERG and A. R. HEAPS (Marconi Avionics, Ltd., Combat Aircraft Controls Div., Rochester, Kent, England) IN: Design and advanced concepts of avionics/weapons system integration; Proceedings of the Symposium, London, England, April 3, 4, 1984. London, Royal Aeronautical Society, 1984, 6 p.

Attention is given to current and projected trends in the design requirements of Digital Flight Control Systems which seek to enhance system capabilities through the electronic linking of the various automatic piloting aids. The piloting aids have, over years of development, reached high levels of complexity in order to meet the demands of both lower inherent stability in aircraft configurations and enhanced maneuvering degrees-of-freedom. A discussion is conducted concerning integrated system architecture, flight control computers, airborne sensors, and software design. O.C.

A85-21679
CHARACTERISTIC MOTIONS FOR SIMULATION OF POST-STALL MANOEUVRES AND FLIGHT INSTABILITIES

M. E. BEYERS (National Research Council of Canada, Unsteady Aerodynamics Laboratory, Ottawa, Canada) Aeronautical Society of South Africa and South African Institute of Aeronautical Engineers, Journal (ISSN 0250-3786), vol. 5, no. 1, 1984, p. 20-34. refs

An approach to the problem of experimentally determining the aerodynamic characteristics of aircraft maneuvering in the nonlinear, post-stall flight regime is proposed. The importance of correctly representing the motion characteristics in unsteady aerodynamic measurements under these conditions is recognized; different approaches are indicated, depending on whether the flight is oscillatory or nonoscillatory (aperiodic) and nonplanar or near-planar. The requirements for captive-model experiments designed to yield the instantaneous dynamic-load histories of ramp-shaped intermittent motions and nonplanar oscillatory motions are discussed. The principle of 'orbital epicyclic motion' is introduced and an analysis of its potential for high-alpha nonplanar oscillatory experiments is presented. In the simulation of complex, nonplanar maneuvers an approach is suggested based on complementing the captive-model experiments with wind tunnel free-flight studies of models trimmed at high alpha. Author

A85-21681

A GLOBAL TECHNIQUE FOR AIRCRAFT STABILITY AND CONTROL ANALYSIS

M. H. LOWENBERG (Council for Scientific and Industrial Research, National Institute for Aeronautics and Systems Technology, Pretoria, Republic of South Africa) Aeronautical Society of South Africa and South African Institute of Aeronautical Engineers, Journal (ISSN 0250-3786), vol. 5, no. 1, 1984, p. 41-45. refs

Bifurcation Analysis and Catastrophe Theory Methodology (BACTM) can both explain and predict the limit cycles, hysteresis effects, and discontinuous motion exhibited by high performance aircraft in their high angle-of-attack dynamics. BACTM yields quantitative global stability information, and can contribute to control system design, stability augmentation, dynamic stability envelope determination, aircraft dynamic model structure design, and safer piloting procedures. BACTM's complete, six-degree-of-freedom flight mechanics equations constitute an autonomous dynamical system which incorporates jump, hysteresis, and limit cycle behavior. O.C.

N85-15752*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, Calif.

MORE THAN YOU WANT TO KNOW ABOUT MAXIMUM LIKELIHOOD ESTIMATION Final Report

K. W. ILIFF and R. E. MAINE Jan. 1985 26 p refs Presented at AIAA Atmospheric Flight Mech. Conf., Seattle, 21-23 Aug. 1984 Prepared in cooperation with NASA, Ames Research Center

(NASA-TM-85905; H-1252; NAS 1.15:85905; AIAA-PAPER-84-2070-CP) Avail: NTIS HC A03/MF A01 CSDL 01C

The maximum likelihood estimator has been used to extract stability and control derivatives from flight data for many years. Most of the literature on aircraft estimation concentrates on new developments and applications, assuming familiarity with basic estimation concepts. Some of these basic concepts are presented. The maximum likelihood estimator is briefly discussed and the aircraft equations of motion that the estimator uses. The basic concepts of minimization and estimation are examined for a simple computed aircraft example. The cost functions that are to be minimized during estimation are defined and discussed. Graphic representations of the cost functions are given to help illustrate the minimization process. Finally, the basic concepts are generalized, and estimation from flight data is discussed. Some of the major conclusions for the computed example are also developed for the analysis of flight data. B.W.

N85-15753# California Univ., Los Angeles. Dept. of Electrical Engineering.

FLUTTER CONTROL WITH UNSTEADY AERODYNAMIC MODELS Ph.D. Thesis

S. CHANG Oct. 1984 108 p

(Contract AF-AFOSR-0318-83)

(AD-A147858; AFOSR-84-1002TR) Avail: NTIS HC A06/MF A01 CSDL 20D

This dissertation deals with a generic problem for aircraft: control laws for flutter suppression. Until recently, the system frequency response was approximated by rational functions so that the finite-dimensional L-Q-R theory could be applied. However, discrepancies between theory and practice, especially in transient response, has led to renewed interest in the problem. It would appear the L-Q-R theory would need infinite dimensional state space models. In this research, we first develop a time-domain model for unsteady aerodynamic loads and then couple it with a lumped model for the structural dynamics. We show that the solutions to the resulting input-output system, characterized by integro-differential equations, can be endowed with a state space which is a reflexive Banach space, and the state equations have a unique semigroup solution. We go on to examine the input-output stability for such a system. We show that input-output stability need not imply stability of the states. By a suitable approximation of the Sears function near the origin, we show that infinite dimensional (L2) L-Q-R theory can be applied. We derive optimal

feedback control laws ensuring weak stability of the states, as well as input-output stability. GRA

N85-16048# Joint Publications Research Service, Arlington, Va. INVESTIGATION OF SEMIAUTOMATIC AIRCRAFT CONTROL PROCESSES EMPLOYING TIME REDUNDANCY IN ON-BOARD DIGITAL TRAJECTORY CONTROL COMPUTERS Abstract Only

S. M. FEDOROV, N. N. SUKHIKH, and M. Y. SMUROV In its USSR Rept.: Electron. and Elec. Eng. (JPRS-UEE-84-017) p 49 17 Dec. 1984 Transl. into ENGLISH from Izv. Vyssh. Ucheb. Zaved.: Priborostr. (Leningrad), v. 27, no. 8, Aug. 1984 p 20-24 Original language document previously announced in IAA as A85-10470

Avail: NTIS HC A06

Aircraft semiautomatic control processes are analyzed with allowance for the failure and recovery of the onboard computers using timer redundancy methods. The admissible time of computer recovery is estimated, and results of semifull scale simulation of the digital system are presented for different values of the discreteness period. B.J. (IAA)

N85-16814*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

A REVIEW OF US ARMY AIRCREW-AIRCRAFT INTEGRATION RESEARCH PROGRAMS

D. L. KEY and E. W. AIKEN In AGARD Helicopter Guidance and Control Systems for Battlefield Support 15 p Aug. 1984 refs

Avail: NTIS HC A13/MF A01 CSDL 01C

The desire of the Army for a one crew helicopter that can perform the scout and attack role is forcing the integration of handling qualities and mission management disciplines and concerns. Some recent studies and results in these disciplines are reviewed. The need for a more unified approach to support new helicopter development is described along with a plan to develop fundamental principles needed for efficient man machine interface design. R.S.F.

N85-16819# Rome Univ. (Italy).

HELICOPTER ACTIVE CONTROL WITH ROTOR BLADES RELAXATION

A. DANESI and A. DANESI In AGARD Helicopter Guidance and Control Systems for Battlefield Support 17 p Aug. 1984 refs

Avail: NTIS HC A13/MF A01

An active modal control for high performance combat helicopters in forward flight is presented. A gust alleviation control (G.A.C.) strategy based on the spectral data computed from the flexible blade structural mode of vibration measurements, is employed to relax, by appropriate longitudinal cyclic pitch modulation, the flat wise bending moments induced by environmental disturbances. The restoring cyclic pitch commands are derived processing the output data from an electro-optical laser sensor by means of a microprocessor performing the spectral power density real time computations; these data, obtained implementing a fast fourier transform algorithm and observed within a frequency window centered at the first bending mode frequency, are employed as a measure of the actual vibrational level existing on the blade. To reduce the helicopter rigid response sensitivity to the G.A.C. system actuators, its driving signals are applied to the longitudinal pitch decoupling unit making the helicopter attitude and vertical velocity component decoupled, the last one regulated by the collective pitch channel through a radioaltimeter closure. The effectiveness of the G.A.C. system is investigated by digital simulations. M.G.

N85-16876 Purdue Univ., Lafayette, Ind.
TIME SERIES ANALYSIS OF CLOSED-LOOP PILOT VEHICLE DYNAMICS Ph.D. Thesis
 D. J. BIEZAD 1984 275 p

Avail: Univ. Microfilms Order No. DA8423330

The off line development of linear discrete autoregressive models for man machine closed loop flight performance is presented. The development includes single input, single output (single channel) and multiple input, multiple output (multichannel) closed loop systems. Previous research is consolidated by extensive surveys of both single and multichannel closed loop modeling and is extended into a comprehensive joint autoregressive man machine identification process. In single channel closed loop tracking tasks, pilot manual control is modeled in terms of linear discrete transfer functions which are parsimonious and guaranteed stable. The transfer functions are found by applying a modified superposition time series generation technique to relatively short data records, approximately 25 seconds long. The resulting model is then validated and analyzed. Results from a piloted laboratory simulation of single and double integrator controlled elements (longitudinal axis) agree with previous research findings. The development of the multichannel identification process is also described.

Dissert. Abstr.

N85-16877*# Systems Technology, Inc., Mountain View, Calif.
MISSION-ORIENTED REQUIREMENTS FOR UPDATING MIL-H-8501. VOLUME 1: STI PROPOSED STRUCTURE Final Report

W. F. CLEMENT, R. H. HOH, S. W. FERGUSON, III, D. G. MITCHELL, I. L. ASHKENAS, and D. T. MCRUER Jan. 1985 150 p refs 2 Vol.

(Contract NAS2-11304)

(NASA-CR-177304-VOL-1; NAS 1.26:177304-VOL-1;

USAAVSCOM-TR-84-A-6; STI-TR-1194-1-1) Avail: NTIS HC A07/MF A01 CSCL 01C

The structure of a new flying and ground handling qualities specification for military rotorcraft is presented. This preliminary specification structure is intended to evolve into a replacement for specification MIL-H-8501A. The new structure is designed to accommodate a variety of rotorcraft types, mission flight phases, flight envelopes, and flight environmental characteristics and to provide criteria for three levels of flying qualities, a systematic treatment of failures and reliability, both conventional and multiaxis controllers, and external vision aids which may also incorporate synthetic display content. Existing and new criteria were incorporated into the new structure wherever they could be substantiated.

R.S.F.

N85-16878*# Systems Technology, Inc., Mountain View, Calif.
MISSION-ORIENTED REQUIREMENTS FOR UPDATING MIL-H-8501. VOLUME 2: STI BACKGROUND AND RATIONALE Final Report

W. F. CLEMENT, R. H. HOH, D. G. MITCHELL, and S. W. FERGUSON, III Jan. 1985 113 p refs 2 Vol.

(Contract NAS2-11304)

(NASA-CR-177304-VOL-2; NAS 1.26:177304-VOL-2;

USAAVSCOM-TR-84-A-6; STI-TR-1194-1-2) Avail: NTIS HC A06/MF A01 CSCL 01C

A supplement to the structure of a new flying and ground handling qualities specification for military rotorcraft structure is presented in order to explain the background and rationale for the specification structure, the proposed forms of criteria, and the status of the existing data base. Critical gaps in the data base for the new structure are defined, and recommendations are provided for the research required to address the most important of these gaps.

R.S.F.

N85-16879# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio.

DESIGN OF A DIGITAL RIDE QUALITY AUGMENTATION SYSTEM FOR COMMUTER AIRCRAFT Ph.D. Thesis, Kansas Univ.

T. A. HAMMOND 1984 379 p

(AD-A148233; AFIT/CI/NR-84-84D) Avail: NTIS HC A17/MF A01 CSCL 01D

This project was initiated based on the goal of making the ride of the commuter aircraft as smooth as the ride experienced on the major commercial airliners. The objectives of this project were to design a digital, longitudinal mode ride quality augmentation system (RQAS) for a commuter aircraft, and to investigate the effect of selected parameters on those designs. The initial stage of this research was the development of an interactive control augmentation design (ICAD) program for use in the design and evaluation of the candidate RQASs. This computer aided design program included both optimal and classical design approaches for either continuous or digital systems, and provided data for analyses in both the time and frequency domains. Both optimal and classical RQAS designs were generated for the five flight conditions selected as representative of a typical commuter mission, using a Cessna 402B. These RQASs used direct lift flaps and the elevator for control of the longitudinal accelerations. The design parameters selected include the sample time, computation delay time, servo bandwidth, and the flap and elevator control power. Optimal and classical point designs, based on the nominal design parameters, are presented for all five flight conditions. Parametric analyses for all five flight conditions for both the optimal and classical designs are also presented.

GRA

N85-16880# Naval Research Lab., Washington, D. C.
USING THE CONTROL SYSTEM DESIGN ENVIRONMENT IN THE DESIGN OF A DATA LINK RECEIVER UNIT FOR THE COAST GUARD HH-65A HELICOPTER M.S. Thesis

F. S. FOX Jun. 1984 166 p

(AD-A148624) Avail: NTIS HC A08/MF A01 CSCL 17B

This thesis is an attempt to prove the value of the Control System Design Environment by designing a shipboard or ground-based data link receiver to communicate with the data link installed in the Coast Guard HH-65A helicopter. The Control System Design Environment was intended to allow a designer to use a high-level language to describe the required inputs and outputs of a system. This high-level language, the Control System Design Language (CSDL) is translated into a list of primitives by a Pascal program, CSDL.PAS. The primitive list is then compiled into assembly language by a FORTRAN program, NEWCSDL.FOR. The final output includes the hardware and software lists to build a controller that meets the designer's specifications. This particular project includes a project design much more ambitious than any previously attempted in the Control System Design Environment.

Author (GRA)

N85-16881# Dornier-Werke G.m.b.H., Friedrichshafen (West Germany).

FLIGHT TEST OF THE OPEN LOOP GUST ALLEVIATION (OLGA) SYSTEM Final Report, Dec. 1983

H. BOEHRET, H. BUCHHOLZ, W. WAGNER, and H. WUENNENBERG Bonn Bundesministerium fuer Forschung und Technologie Oct. 1984 75 p refs In GERMAN; ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie

(BMFT-FB-W-84-038; ISSN-0170-1339) Avail: NTIS HC A04/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 16

A gust alleviation system was applied to low wing loading and high aspect ratio aircraft in order to decrease gust induced vertical acceleration. An open loop gust alleviation system (OLGA) was realized. Gust angle is calculated from sensor signals and fed to the actuators which control the symmetric aileron as lift flaps and the horizontal stabilizer. Flight tests of the aileron rod control, for certification and parameter identification, for system optimization, and the demonstration of system efficiency show a substantial

09 RESEARCH AND SUPPORT FACILITIES (AIR)

decrease in the gust induced vertical acceleration and pitch rate in the frequency range below 3 Hz. However, passenger comfort is far more determined by higher frequencies than expected. Problems are found by stimulating the natural frequencies of the aircraft structure. A fundamental improvement of system behavior is reached by implementation of specific notch filters.

Author (ESA)

09

RESEARCH AND SUPPORT FACILITIES (AIR)

Includes airports, hangars and runways; aircraft repair and overhaul facilities; wind tunnels; shock tube facilities; and engine test blocks.

A85-19270#

THE ACCURACY OF TRIALS WITH POWERED 1/2 MODELS IN THE S2MA WIND TUNNEL [PRECISION DES ESSAIS DE 1/2 MAQUETTES MOTORISEES A S2MA]

J. F. PIAT (ONERA, Centre d'Essais de Modane, Modane, Savoie, France) ONERA, TP, no. 1984-156, 1984, 22 p. In French. (ONERA, TP NO. 1984-156)

The fidelity of the scale-up of data gathered with compressed air turbo-powered simulations of commercial transport aircraft wing-nacelle configurations using a 1/2 model in the ONERA S2MA wind tunnel is assessed. The amount of drag induced on the wing is measured by a balance in the wall mount for the model and account can also be taken of the power produced by the jet and the pressure of the flow into the engine nacelle. It is found that the model faithfully causes flow-broadening behind the nacelle and jets. Defective data from short-term trials have been ameliorated by extending the trial duration to gather more data, although cross-checking is necessary for any conclusions to be drawn. The wind tunnel data are usually accurate to an average of 0.4 percent, with drag predictions being within 0.3 percent at a 76 percent level of certainty. M.S.K.

A85-19271#

TESTS OF AIR INLETS ON CIVIL AIRCRAFT [ESSAIS DE PRISES D'AIR D'AVION CIVIL]

P. WAGNER (ONERA, Centre d'Essais de Modane, Modane, Savoie, France) and J. C. RAYNAL (ONERA, Centre d'Essais de Fauga-Mauzac, Noe, Haute-Garonne, France) ONERA, TP, no. 1984-157, 1984, 55 p. In French. refs (ONERA, TP NO. 1984-157)

The apparatus and techniques used in tests of turbojet air inlet configurations for engine nacelles on general aviation aircraft by ONERA are described. The trials are carried out to validate designs suitable for both landing and take-off flight at high angles of attack and for maximum efficiency cruise flight. Attention is given to disturbances in the flow once it enters the nacelle, the drag penalty imposed on the aircraft by the presence of the nacelle, limiting flow separation during low speed flight, and flow distortions caused by wind during low speed flight. The tests are performed in the S1MA and F1 wind tunnels. Up to 300 pressure sensors can be used in and around diffusers in the F1 tunnel, which is also equipped for investigations of separation occurrence in response to varying Re and Mach numbers up to 0.3. The S1MA wind tunnel permits velocity simulation up to Mach 0.9. The flow through a model nacelle is monitored with a rake within the inlet and before the compressor vanes. M.S.K.

A85-19272#

TESTS, IN THE TRANSONIC REGIME, OF A MODEL MOTORIZED BY A BLOWING TURBINE 23 CM IN DIAMETER (9 INCHES) IN THE S1MA WIND TUNNEL [ESSAIS, DANS LE DOMAINE TRANSSONIQUE, DE MAQUETTE MOTORISEE PAR TPS DE 23 CM DE DIAMETRE /9 POUCE/ DANS LA SOUFFLERIE S1MA]

J. P. BECLE (ONERA, Centre d'Essais de Modane, Modane, Savoie, France) ONERA, TP, no. 1984-158, 1984, 12 p. In French.

(ONERA, TP NO. 1984-158)

The test apparatus and procedures employed with a 23 cm diam blowing turbine to characterize engine nacelle/wing interactions in the S1MA wind tunnel are outlined. The turbine is fed compressed air and is mounted on a balance to measure associated forces and inclinations in transonic and low speed, high Re flows at temperatures up to 80 C. Air at pressures up to 9 bar flows through the inlet. The blowing turbine is mounted on the wing of a half model with a fuselage 6.4 m long. Tests are performed in Mach 0.5-0.82 flows at angles of deflection of 0-4 deg and turbine speeds of 10,000-34,000 rpm. The half-model, being held by a balance, furnishes engine nacelle drag data when tested with and without the engine in equivalent flows. M.S.K.

A85-19402#

THEORETICAL STUDY OF BLOCKAGE EFFECT OF WIND-TUNNEL WALL ON WAKE OF TWO-DIMENSIONAL FLAT PLATE NORMAL TO PLANE WALL

S. OKAMOTO (Shibaura Institute of Technology, Tokyo, Japan) and T. OKAMOTO (Tokyo Institute of Technology, Tokyo, Japan) Japan Society for Aeronautical and Space Sciences, Transactions (ISSN 0549-3811), vol. 27, Nov. 1984, p. 134-144. refs

A theoretical study was made of the blockage effect of an upper wall of wind-tunnel on the wake behind a two-dimensional flat plate normal to a ground wall. The flow studied was an incompressible potential flow past a normal plate having a closed wake region in which a stationary vortex exists. The streamlines and surface-pressure distribution were obtained. From these results it was found that the drag of a normal plate increases and the closed wake region is reduced with an increasing ratio of plate height (H) to tunnel height (h), and the blockage effect can be ignored so long as the ratio H/h is less than 0.05. Author

A85-19403#

EXPERIMENTAL INVESTIGATION OF BLOCKAGE EFFECT OF UPPER WALL OF WIND-TUNNEL ON WAKE OF TWO-DIMENSIONAL FLAT PLATE NORMAL TO PLANE BOUNDARY

S. OKAMOTO (Shibaura Institute of Technology, Tokyo, Japan) Japan Society for Aeronautical and Space Sciences, Transactions (ISSN 0549-3811), vol. 27, Nov. 1984, p. 145-154. refs

This paper describes an experimental investigation on the blockage effect of an upper wall of wind-tunnel on the wake of a two-dimensional flat plate normal to a plane boundary in a uniform stream. The experiment was carried out in a 40 cm x 40 cm NPL type wind-tunnel having the working section of 2 m long. The distributions of velocities and static pressures of the flow field, the recirculation region behind a flat plate, the surface pressure and the drag coefficient of a flat plate, and the shear flow near the wall in the wake were measured and the results were discussed in comparison with those of the existing investigations and the theory. Author

A85-19456*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

STATUS OF WARM FOG DISPERSAL RESEARCH

V. W. KELLER (NASA, Marshall Space Flight Center, Atmospheric Sciences Div., Huntsville, AL) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 4 p. NASA-supported research. refs (AIAA PAPER 85-0010)

A new concept for dispersing warm fog is presented. This brute force technique uses large volume recycled water sprays.

Energy requirements for this technique are an order of magnitude less than those to operate a thermo-kinetic system. An important side benefit is the considerable emergency fire extinguishing capability it provides along the runway. Tests conducted to provide drop spectra measurements and temperature response measurements of suitable water sprays are described. Three mobile firefighting modules capable of spraying up to 630 l/s (10,000 gpm) to a height in excess of 50 m were utilized. Periodic operation of two parallel rows of nozzles in a heavy fog resulted in downwind-correlated increases in the visual range measured with a forward scatter visibility meter. Author

A85-19483#
VARIABLE-TEMPERATURE WATER TUNNEL FOR HIGH REYNOLDS NUMBERS

W. H. STAHL (University of Petroleum and Minerals, Dhahran, Saudi Arabia) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 8 p. refs
 (AIAA PAPER 85-0051)

The possibility of using a water tunnel with variable fluid temperature to achieve high Reynolds numbers for hydrodynamic and aerodynamic testing is investigated. Characteristics of such a water tunnel are compared to those of a low-speed wind tunnel operating at normal conditions, on the basis of the same Reynolds number in both tunnels. The advantages offered by the variable-temperature water tunnel with regard to tunnel dimensions, power requirements, and observation times led to a preliminary design of a small pilot water tunnel with heating and cooling of the fluid, which is presented. The problem of cavitation is considered and found to be not very restrictive for testing practical configurations. Author

A85-19485*# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio.

FREQUENCY RESPONSE OF A JET ENGINE TEST FACILITY AIR SUPPLY SYSTEM

M. E. FRANKE (USAF, Institute of Technology, Wright-Patterson AFB, OH) and M. L. ROSS (NASA, Johnson Space Center, Houston, TX; USAF, Institute of Technology, Wright-Patterson AFB, OH) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 7 p. refs
 (AIAA PAPER 85-0053)

The frequency response of a laboratory scale model of a portion of the air supply system of an engine test facility is obtained both experimentally and using one-dimensional, small-signal, distributed parameter theory. The effects of line terminations and mean flow are considered. Good agreement between experiment and theory is obtained. Predictions are extended to a full scale test facility air supply system operating under several possible test conditions. Author

A85-19486#
MACH-10 HIGH REYNOLDS NUMBER DEVELOPMENT IN THE NSWC HYPERVELOCITY FACILITY

R. A. KAVETSKY and J. A. F. HILL (U.S. Navy, Naval Surface Weapons Center, Silver Spring, MD) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 9 p.
 (AIAA PAPER 85-0054)

In order to obtain higher boundary layer transition on reentry body models, the hypervelocity test facility presently treated has undergone a development program which resulted in the achievement of a maximum Reynolds number of 20 million at Mach 10. Predictions of natural transition were verified during development program testing, and altitude simulation range has been increased. It is noted that an ablative 'flow restrictor' used to mitigate expansion waves created by diaphragm had to be designed to meet severe operating requirements with respect to both operating time and temperature. O.C.

A85-19497#

A STUDY OF THE FLOW RECIRCULATION PROBLEMS WITHIN AN ANECHOIC HOVER CHAMBER

M. LESCAULT and F. VILLANUEVA (U.S. Military Academy, West Point, NY) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 7 p. refs
 (AIAA PAPER 85-0071)

Problems have been observed with apparent recirculation in an anechoic hover chamber at the NASA/Ames Research Center during certain tests of model rotor blades. Tests were performed in a 1/7 scale model of the chamber to identify the problem and investigate possible causes. A flow visualization study was conducted on two model rotors with different aspect ratios to examine two theories concerning the cause of the recirculation. The first theory is that empty space beneath the collector floor induces turbulence to occur which creates a high pressure region, causing the flow to seep back through the collector. The second theory involves blade tip vortices produced by the rotor. These tip vortices induce a velocity in the dead air beneath the floor that causes the flow to recirculate back through the collector. Results show that the theories each have some validity and additively appear to cause the recirculation problem. Author

A85-19512#

ENVIRONMENTAL TEST CAPABILITIES OF THE AIR FORCE MCKINLEY CLIMATIC LABORATORY

C. W. DRAKE (USAF, Climatic Laboratory, Eglin AFB, FL) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 7 p. refs
 (AIAA PAPER 85-0089)

Aircraft testing capabilities of the Air Force's Climatic Laboratory are outlined. The facility has chambers large enough for full-size aircraft to eliminate discrepancies sometimes arising between laboratory and field tests. A 3.2 million cubic feet Main Chamber is equipped to simulate up to 15 in. of rainfall per hour, winds to 60 mph, snow, solar radiation, 10-95 percent humidity, and temperatures from -65 to +165 F. Aircraft engines can be run up to full afterburner during the tests, with the aircraft strapped down by steel cables and the exhaust funneled from the building. Icing tests with frame sprays can be performed in another chamber, as can controlled snowfall rates or direct snow ingestion. A sun, wind, rain and dust chamber allows examinations of dust penetration into aircraft at any simulated latitude. The chamber can also be used to test aircraft reactions to blown sand. Finally, a salt fog facility permits testing for electrochemical corrosion, electrical effects due to salt deposits, and physical effects caused by clogging or binding of moving parts. M.S.K.

A85-19515#

LIGHTNING SIMULATION FACILITIES IN THE UNITED STATES AND EUROPE

L. C. WALKO and J. L. HEBERT (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 7 p.
 (AIAA PAPER 85-0093)

The use of sophisticated avionics systems and non-metallic structures has enhanced aircraft susceptibility to, and the need for protection from, the lightning threat. Some of the lightning aspects may be simulated and this has established lightning simulation as a valuable aid in aircraft design. This paper describes the lightning threat and existing lightning simulation standards. It overviews lightning simulation facilities in the United States and Europe. Author

A85-19577#

AUTOMATED VISIBILITY MEASUREMENTS FOR AIRPORTS

J. T. BRADLEY and S. M. IMBEMBO (NOAA, Test and Evaluation Div., Sterling, VA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 9 p. refs (AIAA PAPER 85-0191)

An algorithm has been developed which, when used with the input from a visibility sensor, can provide a responsive and representative visibility observation for pilots and other users. The algorithm enables a continuous weather watch to be provided which responds better to varying and rapidly changing visibility conditions. In conjunction with proper sensor siting, the technique provides an observation which is specific for the airport touchdown zone and is general for airport environs. Various visibility sensors have been evaluated for use with the developed algorithm. Results of sensor comparisons show that each type of measurement technique (extinction, forward scatter, and backscatter) has a typical response in various types of weather phenomena, which may necessitate some minor tradeoffs between requirements and sensor performance capabilities. V.L.

A85-19601*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

GENERALIZED ADAPTIVE-WALL WIND TUNNELS

S. S. DAVIS (NASA, Ames Research Center, Aerodynamics Research Branch, Moffett Field, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 12 p. refs (AIAA PAPER 85-0225)

Adaptive-wall technology is being seriously considered for many aeronautical wind tunnel applications. A new degree of freedom is introduced into adaptive-wall wind tunnels. It is shown that the adaptive control system used to adjust wall boundary conditions may be used to select a wide variety of flow fields. These flow fields, in turn, may be directly related to many useful unconfined or semiconfined flows. The generalized adaptive-wall concept is demonstrated for both two- and three-dimensional flows using simple analytical techniques. Author

A85-19602#

IMPROVEMENTS IN LOW REYNOLDS NUMBER TESTING IN THE NSWC HYPERVELOCITY WIND TUNNEL NO. 9

E. R. HEDLUND and W. C. RAGSDALE (U.S. Naval Surface Weapons Center, Silver Spring, MD) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 10 p. refs (AIAA PAPER 85-0226)

This paper discusses recent developments in the low Reynolds number testing capability in the NSWC Hypervelocity Wind Tunnel No. 9. Through improvements to the vacuum system and modified heater operation, the tunnel's freestream Reynolds number has been lowered to 50,000/ft. Pressure and temperature surveys of the flow revealed adequate test core area for testing. This paper also describes some unique force testing hardware as well as a flow discharge flow visualization technique which has been recently implemented. Author

A85-19603*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

STUDIES OF CONDENSATION EFFECTS ON AIRFOIL TESTING IN A TRANSONIC CRYOGENIC TUNNEL

R. M. HALL (NASA, Langley Research Center, Hampton, VA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 13 p. refs (AIAA PAPER 85-0229)

In the context of an overall development of transonic, cryogenic wind tunnel technology, NASA has been investigating the onset of condensation effects in nitrogen gas. The temperature at which condensation occurs determines the minimum operating temperature (MOT) of cryogenic tunnels. The apparatus and airfoils are discussed, taking into account a description of the 0.3-m Transonic Cryogenic Tunnel (TCT), the drag rake, the airfoils, and

the technique used for determining the onset of condensation effects. Attention is also given to the types of nucleation processes, the relative sensitivity of drag rake and surface pressure measurements, correlations between data and theory, the prediction of minimum operating temperatures for the 0.3-m TCT, and MOT's for different tunnels. G.R.

A85-19618*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

MEASUREMENTS OF WATER FILM CHARACTERISTICS ON AIRFOL SURFACES FROM WIND-TUNNEL TESTS WITH SIMULATED HEAVY RAIN

E. C. HASTINGS, JR. and G. S. MANUEL (NASA, Langley Research Center, Subsonic Aerodynamics Branch, Hampton, VA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 7 p. refs (AIAA PAPER 85-0259)

This paper discusses some of the surface water characteristics obtained during recent simulated heavy rain experiments conducted at the Langley Research Center. Water film distributions and discrete film thickness measurements on several model wings are discussed. The water film distributions on the upper surfaces are shown in photographs from cameras mounted above the models, and film thickness data are presented which were obtained using resistance sensors mounted flush with the upper and lower wing model surfaces. The paper also discusses potential sources of performance decrements indicated by the data. Author

A85-19655*# Research Triangle Inst., Hampton, Va.

THE MISSION ORIENTED TERMINAL AREA SIMULATION (MOTAS)

P. B. NAFTEL (Research Triangle Institute, Hampton, VA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 10 p. refs (Contract NAS1-15992) (AIAA PAPER 85-0308)

A new simulation facility is described in which flight management and flight operations research studies can be conducted in a highly realistic terminal area environment. The historical evolution and justification of the facility is discussed, along with the design configuration of the system hardware and software. Details are provided on the traffic management features of the terminal area model as well as the human controller and multicockpit interface capabilities. The facility is currently operational with two cockpit simulators, two air traffic control (ATC) stations, four pseudo pilot stations (PPS), a metering and spacing system of traffic flow control management, and terminal area models providing two route structure environments: area navigation (RNAV) for advanced-equipped aircraft and vectoring for conventionally-equipped aircraft. Plans for future experiments utilizing the facility are discussed. Author

A85-19659#

MODULAR SIMULATORS, THEIR FEASIBILITY, DESIGN, AND PROCUREMENT

S. SEIDENSTICKER (Logicon, Inc., Tactical and Training Systems Div., San Diego, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 9 p. (AIAA PAPER 85-0312)

The concept of modularity has enjoyed popular support and various degrees of successful implementation. The basis benefits of modularity are related to flexibility, independent construction, and modification possibilities. The present investigation is concerned with questions regarding a utilization of the concept of modularity in the case of flight simulators. An important requirement regarding such a utilization is related to the definition of the modules, primarily by function, but also by constraints and restrictions. Standards governing the design and implementation of the modules and interfaces must be set up and adhered to. Attention is given to impact on cost and development time, implementation approaches, interfacing modules, potential impact on technology, the program structure, a cockpit procedures trainer,

a mini-aero model, a mini-propulsion model, a cockpit module, an operational flight trainer, and the motion system. G.R.

A85-19661*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

THE ALTITUDE WIND TUNNEL (AWT) - A UNIQUE FACILITY FOR PROPULSION SYSTEM AND ADVERSE WEATHER TESTING

R. CHAMBERLIN (NASA, Lewis Research Center, Cleveland, OH) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 12 p. refs (AIAA PAPER 85-0314)

A need has arisen for a new wind tunnel facility with unique capabilities for testing propulsion systems and for conducting research in adverse weather conditions. New propulsion system concepts, new aircraft configurations with an unprecedented degree of propulsion system/aircraft integration, and requirements for aircraft operation in adverse weather dictate the need for a new test facility. Required capabilities include simulation of both altitude pressure and temperature, large size, full subsonic speed range, propulsion system operation, and weather simulation (i.e., icing, heavy rain). A cost effective rehabilitation of the NASA Lewis Research Center's Altitude Wind Tunnel (AWT) will provide a facility with all these capabilities. Author

A85-19662# DEVELOPMENT OF THE UTA HIGH REYNOLDS NUMBER TRANSONIC WIND TUNNEL

D. R. WILSON and S. Y. CHOU (Texas, University, Arlington, TX) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 8 p. refs (AIAA PAPER 85-0315)

The development history, operational theory, support systems, and results of test section calibration studies of the UTA High-Reynolds Number Transonic Wind Tunnel are presented. The facility, first operated in January 1984, is a Ludwig tube tunnel. The test section measures 7.3 by 9.15 inches and is 25.4 inches long; the porous walls are of conventional design with the porosity varied manually from 3.5 to 10 percent for wave cancellation in supersonic flows, and for partially alleviating wall interference effects. The air supply system consists of a low-pressure compressor providing a flow rate of 84 cu ft/min at a maximum pressure of 200 psig, and a high-pressure compressor providing a flow rate of 44 cu ft/min at 1000 psig. During the calibration procedures 500 psi transducers were used, restricting the lower operating limit to static pressure levels of 40 psi or greater. With the current data acquisition system the pressure signals are measured to within + or - 0.25 percent. Schematic and block diagrams are included. L.T.

A85-19678*# National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.

THE WESTERN AERONAUTICAL TEST RANGE OF NASA AMES RESEARCH CENTER

A. L. MOORE (NASA, Flight Research Center, Edwards, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 16 p. (AIAA PAPER 85-0316)

An overview of the Western Aeronautical Test Range (WATR) of NASA Ames Research Center (ARC) is presented in this paper. The three WATR facilities are discussed, and three WATR elements - mission control centers, communications systems, real-time processing and display systems, and tracking systems - are reviewed. The relationships within the NASA WATR, with respect to the NASA aeronautics program, are also discussed. Author

A85-19709*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

ANALYTICAL AND PHYSICAL MODELING PROGRAM FOR THE NASA LEWIS RESEARCH CENTER'S ALTITUDE WIND TUNNEL (AWT)

J. M. ABBOTT, J. H. DIEDRICH, J. F. GROENEWEG, L. A. POVINELLI, L. REID, J. J. REINMANN, and J. R. SZUCH (NASA, Lewis Research Center, Cleveland, OH) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 13 p. refs (AIAA PAPER 85-0379)

An effort is currently underway at the NASA Lewis Research Center to rehabilitate and extend the capabilities of the Altitude Wind Tunnel (AWT). This extended capability will include a maximum test section Mach number of about 0.9 at an altitude of 55,000 ft and a -20 F stagnation temperature (octagonal test section, 20 ft across the flats). In addition, the AWT will include an icing and acoustic research capability. In order to insure a technically sound design, an AWT modeling program (both analytical and physical) was initiated to provide essential input to the AWT final design process. This paper describes the modeling program, including the rationale and criteria used in program definition, and presents some early program results. Author

A85-19711#

A UNIVERSAL TURBOSHAFT ENGINE TEST CELL - DESIGN CONSIDERATIONS AND MODEL TEST RESULTS

A. I. KARAMANLIS, W. HOELMER, D. C. BELLOMY (General Electric Co., Aircraft Engine Business Group, Cincinnati, OH), R. J. FREULER, and J. D. LEE (Ohio State University, Columbus, OH) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 12 p. (AIAA PAPER 85-0382)

Studies to determine the influence of test cell operational parameters on test cell aerodynamics and engine performance have been made on a scale model of a universal Turboshaft Engine Test Cell. Two engine simulators with different inlet airflow and exhaust system configurations were evaluated and results are presented and discussed. Acceptable and unacceptable test cell aerodynamics were demonstrated qualitatively by flow visualization techniques and quantified by detailed flow measurements. Author

A85-19878

HISTORY OF THE DEVELOPMENT AND MANUFACTURE OF FLIGHT SIMULATORS IN CZECHOSLOVAKIA AND THE REST OF THE WORLD [HISTORIE VYVOJE A VYROBY PILOTNICH SIMULATORU VE SVETE A V CESKOSLOVENSKU]

J. POKORNY (Rudy Letov, Prague, Czechoslovakia) Zpravodaj VZLU (ISSN 0044-5355), no. 5, 1984, p. 269-271. In Czech.

The history of flight simulators, from simple pilot training aids used in the early days of aviation to sophisticated flight simulators made possible with the development of microelectronics and computer technology, is reviewed. In particular, attention is given to the development and production of flight simulators in Czechoslovakia and specific problems that the Czechoslovakian manufacturers have to deal with. The need for a closer cooperation between the supplier and the customer as well as between various specialized manufacturing plants is emphasized. V.L.

A85-20122

BIG WIND AT TULLAHOMA

N. B. BYARS (USAF, Washington, DC) Air Force Magazine (ISSN 0730-6784), vol. 68, Jan. 1985, p. 78-82.

The Air Force's new Aeropropulsion Systems Test Facility (ASTF), scheduled to achieve initial operational capability in September 1985, is described. The facility accommodates the full mission profile of an air-breathing propulsion system at simulated speeds of up to Mach 3.8, at thrust levels of 75,000 lbs, and at altitudes up to 100,000 feet. The facility is designed for both free-jet testing and direct-connect testing, and provides real-time, simultaneous data collection and display. Furthermore, the

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advantages of free-jet testing, such as the ability to test compatibility of an engine with a particular airframe before the production has begun, are discussed. The ASTF is adapted for competitive engine testing and will be used for Joint Advanced Fighter Engine testing. It is suggested that with the ASTF for a laboratory an Advanced Tactical Fighter could well be an affordable and reliable aircraft. L.T.

A85-21422

THE MOST SPECTACULAR EQUIPMENT - ETW [LE PLUS SPECTACULAIRE DES EQUIPEMENTS - ETW]

J. MORISSET Air et Cosmos (ISSN 0044-6971), vol. 22, Dec. 22, 1984, p. 55-57. In French.

The European Transonic Wind Tunnel (ETW) will be built in the next 10 yr as a cooperative effort of four countries and will serve for tests of fixed wing aircraft, helicopter and missile designs. Preliminary design work for the ETW, which will be constructed in Cologne-Forst, began in 1977. The final design features a 2.4 x 2 m test channel, a -183 to +40 C temperature range, a 1.25-4.5 atm. pressure range, Mach 0.15-1.3 flow velocities, a maximum Re of 50 million and a 61,000 hp blower. A cryogenic pressurized mode was chosen to faithfully reproduce flight conditions with scale models, which will be supported on a dynamic, mobile balance equipped with a sting. The flow will be provided by liquid nitrogen at rates up to 200 kg/sec. A smaller version of the ETW was completed in the spring of 1984 in Amsterdam and is serving in definition of the operational techniques for the ETW. M.S.W.

A85-21644

ACOUSTICAL GUIDELINES FOR NEW HELIPORTS

J. LEVERTON (Westland Inc., Arlington, VA) Vertiflite (ISSN 0042-4455), vol. 31, Jan.-Feb. 1985, p. 48-52.

The Helicopter Association International (HAI) program for the development of acoustical guidelines for heliports had as its basis the concept that total sound exposure due to helicopter operations should not exceed, at the nearest residence or location of interest, a specified level of the existing ambient sound exposure level (whichever is higher). It is assumed that areas can be zoned, and therefore classified in acoustic terms, according to their use. In order to allow the proposed guidelines to be used without knowledge of actual helicopter noise data, generalized curves have been developed by HAI which associate noise levels with helicopters of a given class on the basis of vehicle weight and distance. O.C.

N85-15754 Department of the Navy, Washington, D. C. SYSTEM FOR RAPID REPAIR OF DAMAGED AIRFIELD RUNWAYS Patent

P. S. SPRINGSTON, inventor (to Navy) 13 Sep. 1983 5 p Supersedes AD-D009985 (AD-D011325; US-PATENT-4,404,244; US-PATENT-APPL-SN-437092; US-PATENT-CLASS-428-109) Avail: US Patent and Trademark Office CSCL 01E

A membrane of fiberglass-reinforced polyester resin is used as a trafficable cover over a compacted backfilled crater and crushed stone base to impart strength to the repair and prevent foreign object damage to aircraft. The membrane cover is usually prefabricated from several fiberglass matting layers of chopped fiberglass strands chemically bonded to woven fiberglass roving and impregnated with a polyester resin; an anchoring system consisting of holes along the cover perimeter and torque set rock bolts are used in conjunction with special steel bushings to secure the cover to airfield pavement surrounding the crater. GRA

N85-15755*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

DESCRIPTION OF THE INSULATION SYSTEM FOR THE LANGLEY 0.3-METER TRANSONIC CRYOGENIC TUNNEL

P. L. LAWING, D. A. DRESS, and R. A. KILGORE Jan. 1985 27 p refs

(NASA-TM-86274; L-15723; NAS 1.15:86274) Avail: NTIS HC A03/MF A01 CSCL 14B

The thermal insulation system of the Langley 0.3 Meter Transonic Cryogenic Tunnel is described. The insulation system is designed to operate from room temperature down to about 77.4 K, the temperature of liquid nitrogen at 1 atmosphere. A detailed description is given of the primary insulation system consists of glass fiber mats, a three part vapor barrier, and a dry positive pressure purge system. Also described are several secondary insulation systems required for the test section, actuators, and tunnel supports. An appendix briefly describes the original insulation system which is considered inferior to the one presently in place. The time required for opening and closing portions of the insulation system for modification or repair to the tunnel has been reduced, typically, from a few days for the original thermal insulating system to a few hours for the present system. Author

N85-15757*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

ANALYTICAL AND PHYSICAL MODELING PROGRAM FOR THE NASA LEWIS RESEARCH CENTER'S ALTITUDE WIND TUNNEL (AWT)

J. M. ABBOTT, J. H. DEIDRICH, J. F. GROENEWEG, L. A. POVINELLI, L. REID, J. J. REINMANN, and J. R. SZUCH 1985 21 p refs Presented at the 23rd Aerospace Sci. Meeting, Reno, Nevada, 14-17 Jan. 1985; sponsored by AIAA (NASA-TM-86919; E-2413; NAS 1.15:86919; AIAA-85-0379) Avail: NTIS HC A02/MF A01 CSCL 14B

An effort is currently underway at the NASA Lewis Research Center to rehabilitate and extend the capabilities of the Altitude Wind Tunnel (AWT). This extended capability will include a maximum test section Mach number of about 0.9 at an altitude of 55,000 ft and a -20 F stagnation temperature (octagonal test section, 20 ft across the flats). In addition, the AWT will include an icing and acoustic research capability. In order to insure a technically sound design, an AWT modeling program (both analytical and physical) was initiated to provide essential input to the AWT final design process. This paper describes the modeling program, including the rationale and criteria used in program definition, and presents some early program results. Author

N85-15758*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

THE NASA ALTITUDE WIND TUNNEL (AWT): ITS ROLE IN ADVANCED ICING RESEARCH AND DEVELOPMENT

B. J. BLAHA and R. J. SHAW 1985 21 p refs Presented at the 23rd Aerospace Sci. Meeting, Reno, Nevada, 14-17 Jan. 1985; sponsored by AIAA

(NASA-TM-86920; E-2414; NAS 1.15:86920; AIAA-85-0090) Avail: NTIS HC A02/MF A01 CSCL 14B

Currently experimental aircraft icing research is severely hampered by limitations of ground icing simulation facilities. Existing icing facilities do not have the size, speed, altitude, and icing environment simulation capabilities to allow accurate studies to be made of icing problems occurring for high speed fixed wing aircraft and rotorcraft. Use of the currently dormant NASA Lewis Altitude Wind Tunnel (AWT), as a proposed high speed propulsion and adverse weather facility, would allow many such problems to be studied. The characteristics of the AWT related to adverse weather simulation and in particular to icing simulation are discussed, and potential icing research programs using the AWT are also included. Author

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N85-15760# Illinois Univ., Urbana. Dept. of Civil Engineering.
DEVELOPMENT OF A PRELIMINARY ALRS STABILIZED MATERIAL PAVEMENT ANALYSIS SYSTEM (SPAS) Final Report, Apr. 1982 - May 1983

B. J. DEMPSEY, D. JANSSEN, J. THOMAS, P. FREY, and A. IOANNIDES Tyndall AFB, Fla. AF Engineering and Services Center Aug. 1984 171 p
(Contract FY8952-82-60024)
(AD-A147116; AFESC/ESL-TR-83-34) Avail: NTIS HC A08/MF A01 CSCL 01E

This report is an analytical study of soil stabilization as used in Alternate Launch and Recovery Surface (ALRS) design. The study proposes that ALRS pavements can be designed using a mechanistic design approach and a stabilized pavement analysis system (SPAS) is proposed. Stabilized material properties (strength, modulus, fatigue), structural modeling and behavior concepts, and environmental factors (freeze-thaw, frost depth) are utilized in the SPAS development. Inputs required to establish a stabilized base thickness for an ALRS pavement (F-4 loading) are the field strength of the stabilized material and the E sub R_i (measure of resilient modulus) of the fine-grained subgrade. A properly designed ALRS pavement for F-4 loading can accommodate a limited number of C-130 and F-15 load applications. The SPAS thickness design concepts (based on an intact slab approach) are applicable to a broad range of cementitious-stabilized materials (soil-cement, lime-fly ash-aggregate, soil-lime mixtures, similar high strength and modulus SPAS F-4 thickness requirements appear reasonable. Further research and development activities are required to validate SPAS. Technical report ESL-TR-84-25, Response and Performance of Alternate Launch and Recovery Surfaces Containing Stabilized Material Layers, shall report on predicting structural responses for ALRS pavements using stabilized material. Validation of the research shall use information from Test Report ESL-TR-83-46, Performance Data for F-4 Load Cart Operations on Alternate Launch and Recovery Surfaces. GRA

N85-15761# Department of the Navy, Washington, D. C.
AIRCRAFT BARRICADE Patent Application
P. DIGIOVANNIANTONIC and W. J. ZIMMER, inventors (to Navy)
1 Aug. 1983 17 p
(AD-D011316; US-PATENT-APPL-SN-519421) Avail: NTIS HC A02/MF A01 CSCL 01E

A webbing system is disclosed for use as an aircraft barricade wherein a plurality of rectangularly-shaped engaging loops are arranged in an alternating, multi-planar array and suspended across a landing area in the path of an approaching aircraft upon an assembly of support loops stretched between a pair of stanchions and connected on either side to an energy absorbing device. Slidably connected along upper and lower horizontal components of the support loops, the engaging loops are free to move laterally along the support loops toward the longitudinal axis of the aircraft when penetrated by the fuselage so that the aircraft is ensnared about its wings by the loops with equalized loading and its forward motion arrested. GRA

N85-15762# Naval Civil Engineering Lab., Port Hueneme, Calif.
HANGAR HEATING AND ENERGY CONSERVATION MANUAL Final Report, Oct. 1979 - Sep. 1983
J. L. ASHLEY Sep. 1984 110 p
(AD-A147893; AFESC/DEB-TR-84-01) Avail: NTIS HC A06/MF A01 CSCL 01E

Hangars and similar structures require large amounts of energy for space heating. Energy conservation survey techniques for hangars are defined and technical data sheets are included which provide: (1) procedures to identify energy conservation deficiencies; (2) methods to calculate annual energy losses; (3) recommended solutions; and (4) methods to calculate annual energy savings. Author (GRA)

N85-15763# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Cologne (West Germany). Hauptabteilung Windkanale.

EXPERIENCES WITH THE USE OF A SIDE-STRUT MODEL SUPPORT SYSTEM FOR HIGH ANGLES OF ATTACK IN THE TRINSONIK WIND TUNNEL TMK

H. ESCH May 1984 53 p refs In GERMAN; ENGLISH summary Translation is in process as (ESA-TT-895) (DFVLR-MITT-84-09; ESA-TT-895) Avail: NTIS HC A04/MF A01; DFVLR, Cologne DM 22

Experience with a relatively simple model support system for high angles of attack in a blowdown wind tunnel are presented. The advantages of low production costs and low operational costs as compared to the standard system face the disadvantages of increased aerodynamic interference and asymmetrical deformations. Interference tests show the limitations of the use of this system. It can be used in the supersonic domain, especially for higher Mach numbers. It is only conditionally usable in the transonic domain. Author (ESA)

N85-16770# Joint Publications Research Service, Arlington, Va.
AEROPROYEKT DEVELOPS IMPROVED RUNWAY SURFACING

A. VINOGRADOV In its USSR Rept.: Transportation (JPRS-UTR-85-001) p 20-21 15 Jan. 1985 Transl. into ENGLISH from Vozdushnyy Transp. (Moscow), 25 Sep. 1984 p 3
Avail: NTIS HC A09/MF A01

A framed pavement design for aircraft was developed. Prior to concreting, I-beams are placed on the prepared surface of a runway so that, after welding, they form frames. One frame cell covers an area of some 50 square meters. After concreting, each cell forms a finished plate framed by the metal form. The frame acts as a form during concreting and prevents edge creep. Later, as the concrete hardens, the frame becomes an excellent joint component. This type pavement was accepted for operational use at one airport. Work on all-weather pavement is progressing. A.R.H.

N85-16815# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (West Germany).
ADVANCED FLIGHT SIMULATION FOR HELICOPTER DEVELOPMENT

H. HUBER, H. J. DAHL, and A. INGLSPERGER In AGARD Helicopter Guidance and Control Systems for Battlefield Support 14 p Aug. 1984 refs
Avail: NTIS HC A13/MF A01

A simulation capability for both fixed wing and rotary wing aircraft has been developed. The fixed based simulator consists of interchangeable cockpit stations, a computer generated imagery (CGI) visual system, both coupled with the math model simulation computer. Specific integration rigs for avionics, flight controls, and weapon systems can be operated with the simulator. The simulation system is described including cockpit/interface hardware, visual display system, and mathematical modeling. The simulation validity is demonstrated by the verification of the mathematical model and by pilot judgments. Typical simulation tasks for future military applications are discussed. It is concluded that the existing simulator provides a valid tool for helicopter system development. R.S.F.

N85-16816# Centre d'Electronique de l'Armement, Bruz (France).

A SIMULATOR FOR STUDYING HELICOPTER WEAPONS SYSTEMS [UN SIMULATEUR D'ETUDES DE SYSTEMS D'ARMES HELICOPTERE]

M. HUON In AGARD Helicopter Guidance and Control Systems for Battlefield Support 12 p Aug. 1984 refs In FRENCH
Avail: NTIS HC A13/MF A01

A simulator designed to study air to air missile and cannon fire against a helicopter is described. The pilot station is fixed and located in a sphere which serves as a screen on which a TITUS tube projects a synthetic image of the landscape defined by 10,000 facets (SOGITEC G I 10,000 processor). The field is covered

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from 80 degrees around and is completed by horizon projection. A 250 faceted projector generates the target. A transparent, symbolic sighting tube is projected on the sphere by a power tube. The pilot uses a helmet mounted display. The marksman's apparatus is offset and involves a main sighting tube with presentation of a G I 10,000 image and weapons control. Vibration seats are provided. Ambient noise is supplied by a programmable noise generator. The complete simulator is operated from a test direction station. A.R.H.

N85-16817# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
ASSESSMENT OF SIMULATION FIDELITY USING MEASUREMENTS OF PILOTING TECHNIQUE IN FLIGHT

W. F. CLEMENT (Systems Technology, Inc., Mountain View, Calif.), W. B. CLEVELAND, and D. L. KEY /in AGARD Helicopter Guidance and Control Systems for Battlefield Support 12 p Aug. 1984 refs

Avail: NTIS HC A13/MF A01 CSCL 14B

The U.S. Army and NASA joined together on a project to conduct a systematic investigation and validation of a ground based piloted simulation of the Army/Sikorsky UH-60A helicopter. Flight testing was an integral part of the validation effort. Nap-of-the-Earth (NOE) piloting tasks which were investigated included the bob-up, the hover turn, the dash/quickstop, the sidestep, the dolphin, and the slalom. Results from the simulation indicate that the pilot's NOE task performance in the simulator is noticeably and quantifiably degraded when compared with the task performance results generated in flight test. The results of the flight test and ground based simulation experiments support a unique rationale for the assessment of simulation fidelity: flight simulation fidelity should be judged quantitatively by measuring pilot's control strategy and technique as induced by the simulator. A quantitative comparison is offered between the piloting technique observed in a flight simulator and that observed in flight test for the same tasks performed by the same pilots. R.S.F.

N85-16882*# National Aeronautics and Space Administration, Washington, D. C.

RESULTS OF S5 CH TESTS WITH AN ARL (AEROSPACE RESEARCH LABORATORY) CASCADE

A. FOURMAUX Dec. 1984 34 p refs Transl. into ENGLISH of "Resultats d'essais a S5 CH d'une grille d'aubes ARL (Aerospace Research Laboratory)" rept. RT-5/3568-EN, Paris, Mar. 1984 31 p Transl. by Kanner (Leo) Associates, Redwood City, Calif. Original document prepared by ONERA, Paris (Contract NASW-4005)

(NASA-TM-77510; NAS 1.15:77510; ONERA-RT-5/3568-EN)

Avail: NTIS HC A03/MF A01 CSCL 14B

As part of a research agreement between Iowa State University of Science and Technology (ISU) and ONERA, a blade cascade designed and already tested in the United States was manufactured and tested in France. The ONERA cascade wind tunnel and mock-up are described. Attention is focused on defining the upstream conditions of the cascade. Experimental results are presented, as well as comparisons with tests conducted by Detroit Diesel Allison (DDA) in the United States. B.W.

N85-16883*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

LANGLEY MACH 4 SCRAMJET TEST FACILITY

E. H. ANDREWS, JR., M. G. TORRENCE, G. Y. ANDERSON, G. B. NORTHAM, and E. A. MACKLEY Feb. 1985 56 p refs (NASA-TM-86277; L-15827; NAS 1.15:86277) Avail: NTIS HC A04/MF A01 CSCL 14B

An engine test facility was constructed at the NASA Langley Research Center in support of a supersonic combustion ramjet (scramjet) technology development program. Hydrogen combustion in air with oxygen replenishment provides simulated air at Mach 4 flight velocity, pressure, and true total temperature for an altitude range from 57,000 to 86,000 feet. A facility nozzle with a 13 in square exit produces a Mach 3.5 free jet flow for engine propulsion tests. The facility is described and calibration results are presented

which demonstrate the suitability of the test flow for conducting scramjet engine research. Author

N85-16884# Oak Ridge National Lab., Tenn.
EVALUATION OF ARCTIC TEST OF IMPROVED TRITIUM RADIOLUMINESCENT LIGHTING Final Report, Nov. 1983 - Feb. 1984

K. W. HAFF, J. A. TOMPKINS, L. J. HULT, and C. L. BUPP Aug. 1984 73 p (Contract AF PROJ. 2673) (AD-A148215; AFESC/ESL-TR-84-19) Avail: NTIS HC A04/MF A01 CSCL 01E

This test was conducted to determine if the improved generation of tritium radioluminescent runway lighting could effectively support aircraft operations in the Alaskan winter environment. The lighting system was unidirectional and consisted of threshold and touchdown zone lights (each end), edge lights, and Visual Approach Slope Indicator (VASI) lights. The primary lighting layout tested was similar to that required by Military Airlift Command regulations for C-130 operations. Nearly all pilots rated the runway lights satisfactory for use at tactical operating locations. Visual acquisition range was 3 to 5 miles under dark conditions. This distance was decreased by ambient lighting conditions. Pilots landing into the twilight of a setting sun reported as little as 1 mile acquisition range. The VASI system was rated marginal by pilots. Increasing the number of radioluminescent panels used and the distance between the panels significantly improved acquisition and usable ranges. The tritium lights were extremely durable throughout the test. They required no maintenance except an occasional wipe off, and there were no failures or security violations. GRA

N85-16885# Weston (Roy F.), Inc., West Chester, Pa.
INSTALLATION RESTORATION PROGRAM. PHASE 2: STAGE 1 PROBLEM CONFIRMATION STUDY, DULUTH INTERNATIONAL AIRPORT DULUTH, MINNESOTA Final Report

Oct. 1984 213 p Sponsored by Air Force (AD-A148318; AD-E700012) Avail: NTIS HC A10/MF A01 CSCL 13B

The following are among the study's key conclusions: (1) Groundwater occurs under shallow water table conditions in and around all sites investigated. Lateral groundwater gradients typically average about 0.02. While the hydraulic driving force for groundwater contaminant migration is fairly large, the actual rate of movement of groundwater is slow due to the presence of low-permeability glacial till. (2) Regional water table flow is generally northerly. Locally, however, this regional gradient is modified by surface drainageways which intercept the upper few feet of water table flow. Discharge of shallow groundwater to these surface drainageways creates a potential for off-base migration of contaminants. (3) Such migration of contaminants is demonstrated by detection of solvent compounds in the surface drainageway adjacent to the DPDO Storage Area C and by observation of oily discharges in surface drainageways adjacent to the Fuel Storage Area. (4) Part-per-billion level concentrations of the pesticide DDD were found in the bottom sediments of the GMSDA (Goose Missile Site Disposal Area) but off-site migration appears to be negligible. A non-pesticide compound, tentatively identified as PCB, was detected in GMSDA sediments in the same general distribution as the pesticide. GRA

N85-16886# Clemson Univ., S.C. Dept. of Chemical Engineering.

LABORATORY SIMULATION OF SMOKE REDUCTION FROM AIRCRAFT ENGINE TEST CELL EXHAUST USING A FLUIDIZED BED FILTER Final Report, 1 Jun. 1983 - 31 Aug. 1984

R. W. RICE 22 Oct. 1984 37 p (Contract AF-AFOSR-0147-83) (AD-A148600; AFOSR-84-1078TR) Avail: NTIS HC A03/MF A01 CSCL 13B

The lowering of aircraft engine test cell exhaust opacity by fluidized bed filtration of soot was simulated in the laboratory. Smoke from a diesel burner was diluted with ambient air and

passed through a 25 cm diameter cylindrical bed of either 500 or 1000 micron glass spheres. Bed depths ranging from 2.5 to 10 cm and superficial gas velocities of 2 to 60 cm/s were studied. Using separate light-sources and photocell detectors, the optical densities of the bed inlet and outlet gas streams were simultaneously monitored. From these data percentage opacity reduction (POR) values were determined as a function of time. This measure of filtration efficiency was found to increase with bed depth, ranging from roughly 50% for a 2.5 cm deep bed of 1100 micron glass beads to 99% for a 10 cm deep bed of 500 micron beads. No appreciable decline in effectiveness was observed for periods of up to 1.5 hours. Attempts were made to supplement POR results with gravimetric measurements of particle loading and size distribution made using a stack gas sampler (inertial impactor). GRA

N85-16887# Arbeitsgemeinschaft Deutscher Verkehrsflughäfen, Stuttgart (West Germany). Abteilung Verkehr.
ACTIVITIES REPORT ON WEST GERMAN CIVIL AIRPORTS. PART 1: TEXT Annual Report, 1983 [VERKEHRSLEISTUNGEN DER DEUTSCHEN VERKEHRSFLUGHAEFEN. 1: TEXT]
 Jun. 1984 63 p refs In GERMAN 2 Vol.
 (ISBN-3-87977-055-7-PT-1) Avail: NTIS HC A04/MF A01

The 1983 traffic activity report is given for the 11 international and 29 regional West German airports, including West Berlin. Information on the major Austrian airports as well as Basel and Zurich airports and another 200 European and non-European airports is also given. Aircraft movements, passenger numbers, air freight quantities, air mail, commercial traffic figures, evolution graphs over 25 years and vocabulary definitions are included.

Author (ESA)

N85-16888# Arbeitsgemeinschaft Deutscher Verkehrsflughäfen, Stuttgart (West Germany). Abteilung Verkehr.
ACTIVITIES REPORT FOR THE WEST GERMAN CIVIL AIRPORTS. PART 2: TABLES Annual Report, 1983 [VERKEHRSLEISTUNGEN DER DEUTSCHEN VERKEHRSFLUGHAEFEN. 2: TABELLEN]
 1984 81 p refs In GERMAN 2 Vol.
 (ISBN-3-87977-055-7-PT-2) Avail: NTIS HC A05/MF A01

The 1983 traffic activity report for the 11 international and 29 regional West German airports, including West Berlin is summarized. Data on the major Austrian airports as well as Basel airport, Zurich airports and another 200 European and non-European airports is also given. Aircraft movements, passenger numbers, air freight quantities, air mail, commercial traffic figures, evolution graphs over 25 years and vocabulary definitions are presented.

Author (ESA)

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ASTRONAUTICS

Includes astronautics (general); astrodynamics; ground support systems and facilities (space); launch vehicles and space vehicles; space transportation; spacecraft communications, command and tracking; spacecraft design, testing and performance; spacecraft instrumentation; and spacecraft propulsion and power.

A85-19495#
THERMAL DESIGN OF ROTATABLE CRYOGENIC HEAT PIPE JOINTS

E. FRENCH (Rockwell International Corp., Seal Beach, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 10 p. refs (AIAA PAPER 85-0068)

A gas-filled, finned heat exchanger which couples independently sealed heat pipes has been found to be a promising approach to the design of rotatable thermal joints for space applications. Closed-form solutions for the thermal transport characteristics of

such heat exchangers have been combined with heat pipe performance equations to obtain parametric estimates of overall joint capability. Interfin heat conduction is maintained by low-pressure (50 torr or less) helium gas sealed within the joint. In a related experimental study of cryogenic rotating seals, helium leak rates have been measured at room temperature and at 100 K. Preliminary results show at least one seal type which exhibits the very low leak rates consistent with multi-year operation in space. Author

A85-19791*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

THE APPLICATION OF SOME LIFTING-BODY REENTRY CONCEPTS TO MISSILE DESIGN

M. L. SPEARMAN (NASA, Langley Research Center, Hampton, VA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 10 p. refs
 (AIAA PAPER 85-0497)

The aerodynamic characteristics of some lifting-body concepts are examined with a view to the applicability of such concepts to the design of missiles. A considerable amount of research has been done in past years with vehicle concepts suitable for manned atmospheric-entry and atmospheric flight. Some of the concepts appear to offer some novel design approaches for missiles for a variety of missions and flight profiles, including long-range orbital/reentry with transatmospheric operation for strategic penetration, low altitude penetration, and battlefield tactical. The concepts considered include right triangular pyramidal configurations, a lenticular configuration, and various 75-degree triangular planform configurations with variations in body camber and control systems. The aerodynamic features are emphasized but some observations are also made relative to other factors such as heat transfer, structures, carriage, observability, propulsion, and volumetric efficiency. Author

A85-19792#
A PARALLEL QUASI-LINEARIZATION ALGORITHM FOR AIR VEHICLE TRAJECTORY OPTIMIZATION

P. K. A. MENON and L. L. LEHMAN (Integrated Systems, Inc., Palo Alto, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 8 p. refs
 (Contract F08635-83-C-0480)
 (AIAA PAPER 85-0498)

Recent research on parallel computing architectures has generated a need for inherently parallel numerical algorithms to improve speed in 'compute bound' situations such as trajectory optimization. In this paper, a parallel quasi-linearization algorithm is presented for the solution of nonlinear two-point-boundary-value problems arising in flight vehicle trajectory optimization. This approach uses the integrating matrix technique. Optimization of a boost-glide missile trajectory is given as an application example.

Author

A85-20226#
NEWTON ITERATION FORMULAS FOR CORRECTING TEMPERATURE AND PRESSURE IN THERMODYNAMIC CALCULATION OF ROCKET ENGINES

D. FANG (National University of Defense Technology, People's Republic of China) Journal of Engineering Thermophysics, vol. 5, Feb. 1984, p. 1-7. In Chinese, with abstract in English.

In thermodynamic calculation of rocket engines, the method of interpolation is usually accepted for correcting temperature and pressure. But it is convenient for the correction of one variable only and its convergence of successive approximation is slower. In this paper, Newton iteration formulas for correcting temperature and pressure in thermodynamic calculation are deduced from Newton method and thermodynamic differential relationships. Thermodynamic calculation on any section of nozzle is accomplished with these iteration formulas. Examples are given in the paper. Author

A85-20909

**AIR BREATHING SPACE TRANSPORT VEHICLES WITH WINGS
[GEFLUEGELTE LUFTATMENDE RAUMTRANSPORTER]**

U. M. SCHOETTLE (Stuttgart, Universitaet, Stuttgart, West Germany) (Hermann Oberth Gesellschaft, Symposium ueber gefluegelte Raumfahrzeuge, Hanover, West Germany, May 25, 1984) Astronautik (ISSN 0004-6221), vol. 21, no. 4, 1984, p. 108-113. In German. Sponsorship: Deutsche Forschungsgemeinschaft. refs
(Contract DFG-SFB-85)

It is pointed out that the currently available space transportation systems of the Western World will not be able to satisfy demands expected for the turn of the century. The development of new systems is, therefore, necessary. Studies of suitable concepts for space transportation systems have already been conducted. Key technologies for future space transportation systems are based on new structural and propulsion concepts. The present investigation is concerned with the employment of a combined rocket-ramjet engine in a single-stage vehicle with wings, taking into account vehicles with vertical or horizontal launching capabilities. Questions of feasibility are explored exclusively under considerations of technological implementation. The considered combined rocket-ramjet propulsion unit is compared with propulsion systems based entirely on the use of rockets. The propellants are liquid hydrogen and liquid oxygen. It is found that the single-stage rocket-ramjet engine vehicle is feasible on the basis of the technological assumptions discussed by Haefeli et al. (1977).

G.R.

N85-15778*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

**EFFECT OF AERODYNAMIC AND ANGLE-OF-ATTACK
UNCERTAINTIES ON THE MAY 1979 ENTRY FLIGHT CONTROL
SYSTEM OF THE SPACE SHUTTLE FROM MACH 8 TO 1.5**

H. W. STONE and R. W. POWELL Jan. 1985 137 p refs
(NASA-TP-2365; L-15813; NAS 1.60:2365) Avail: NTIS HC
A07/MF A01 CSCL 22B

A six degree of freedom simulation analysis was performed for the space shuttle orbiter during entry from Mach 8 to Mach 1.5 with realistic off nominal conditions by using the flight control systems defined by the shuttle contractor. The off nominal conditions included aerodynamic uncertainties in extrapolating from wind tunnel derived characteristics to full scale flight characteristics, uncertainties in the estimates of the reaction control system interaction with the orbiter aerodynamics, an error in deriving the angle of attack from onboard instrumentation, the failure of two of the four reaction control system thrusters on each side, and a lateral center of gravity offset coupled with vehicle and flow asymmetries. With combinations of these off nominal conditions, the flight control system performed satisfactorily. At low hypersonic speeds, a few cases exhibited unacceptable performances when errors in deriving the angle of attack from the onboard instrumentation were modeled. The orbiter was unable to maintain lateral trim for some cases between Mach 5 and Mach 2 and exhibited limit cycle tendencies or residual roll oscillations between Mach 3 and Mach 1. Piloting techniques and changes in some gains and switching times in the flight control system are suggested to help alleviate these problems.

E.A.K.

CHEMISTRY AND MATERIALS

Includes chemistry and materials (general); composite materials; inorganic and physical chemistry; metallic materials; nonmetallic materials; and propellants and fuels.

A85-20150

**THE CHALLENGE FROM CERAMICS TO METALS IN THE GAS
TURBINE AND RELATED AREAS**

J. C. MOORE (Powder Metallurgy Group, Conference on Developments in Powder Metallurgy Materials, Processes, and Applications, Edinburgh, Scotland, Oct. 24-26, 1983) Powder Metallurgy (ISSN 0032-5899), vol. 27, no. 4, 1984, p. 229, 230.

A brief is made of the present competence in developing a ceramic gas turbine engine to replace the existing high temperature alloy systems, candidate materials are described and design and manufacturing problems are discussed.

Author

A85-20545#

**REVIEW OF THE ORIGIN OF JAPANESE INDUSTRIAL
STANDARD**

T. MORINAGA Japan Institute of Light Metals, Journal (ISSN 0451-5994), vol. 34, Oct. 1984, p. 607-617. In Japanese.

The historical background of the Japanese Industrial Standard (JIS) for Al and Mg alloys used in aircraft components is reviewed. The HD alloy (Al-Mg-Zn system containing Mn and Cr for inhibiting stress corrosion) developed for high strength aircraft components during World War II is described. The HD alloy has gained wide acceptance for commercial uses, currently is known as a three-dimensional Al alloy, and is also described in the JIS-7N01. The manufacturing methods of these Al and Mg alloys are outlined. The specifications and chemical composition of Al and Mg alloys used in aircraft components are listed.

S.H.

A85-20758

**DEVELOPMENT OF A FATIGUE CRACK PROPAGATION MODEL
OF INCOLOY 901**

B. J. SCHWARTZ, N. G. ENGBERG, and D. A. WILSON (United Technologies Corp., Pratt and Whitney Group, West Palm Beach, FL) IN: Fracture mechanics. Philadelphia, PA, American Society for Testing and Materials, 1984, p. 218-241. refs

The present investigation is concerned with interpolative crack propagation models of Incoloy 901. The models were developed from data generated by an American aerospace company under a Navy contract. Attention is given to the experimental program for obtaining crack propagation data, aspects of mathematical model development, the effect of loading rate, the effect of positive stress ratio, the effect of negative stress ratio, the effect of temperature, prior plastic deformation, and the statistics of the model. The examined model is considered a highly accurate tool for describing the crack propagation rates in Incoloy 901 under constant peak amplitude loading.

G.R.

A85-20759

**FATIGUE CRACK GROWTH BEHAVIOR OF 7XXX ALUMINUM
ALLOYS UNDER SIMPLE VARIABLE AMPLITUDE LOADING**

P. E. BRETZ, A. K. VASUDEVAN, R. J. BUCCI, and R. C. MALCOLM (Aluminum Company of America, Alloy Technology Div., Alcoa Center, PA) IN: Fracture mechanics. Philadelphia, PA, American Society for Testing and Materials, 1984, p. 242-265. refs
(Contract N00019-79-C-0258)

This investigation examines the influence of temper and purity on the fatigue crack growth (FCG) behavior of four 7XXX aluminum alloys (7075-T6, 7075-T7, 7050-T6, 7050-T7) tested using a periodic single overload spectrum at low stresses. The loading sequence consists of a periodic single overload spike occurring once every 800 constant amplitude cycles; the overload spike is 1.8 times the constant amplitude load peak. All tests have been performed in high humidity (greater than 90 percent relative humidity) air at a frequency of 20 Hz and a constant amplitude load ratio of R =

0.33. The observed microstructural effects on transient (that is, spectrum) FCG behavior are contrasted with those for steady-state (constant load amplitude) fatigue performance. Author

A85-20790

INTERPRETATION OF FATIGUE CRACK GROWTH IN ALUMINIUM ALLOYS UNDER PROGRAMMED BLOCK LOADING

M. GABRA and C. BATHIAS (Compiègne, Université de Technologie, Compiègne, France) *Fatigue of Engineering Materials and Structures* (ISSN 0160-4112), vol. 7, no. 4, 1984, p. 285-298. Research supported by the Direction des Recherches, Etudes et Techniques. refs

The effect of cycle ratio on the crack-propagation rate for two aluminum alloys is analyzed. Fatigue-crack growth under programmed block loading is presented and linear damage accumulation is established for some flight-simulation tests. Aspects covered include microscopic and fractographic observations. The incidence of crack closure is examined, and the concept of equivalent constant amplitude is applied. The agreement between predictions and test results is very promising. Author

A85-20865#

AN EXPERIMENTAL INVESTIGATION OF AN UNSTEADY COMBUSTING FLOW IN A PULSE COMBUSTOR

J. O. KELLER (Sandia National Laboratory, Livermore, CA) and K. SAITO (Toshiba Corp., Fuji, Japan) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 10 p.* Research supported by the U.S. Department of Energy and Toshiba Corp. refs (AIAA PAPER 85-0322)

Pulse combustion devices exhibit exceedingly high thermal efficiency and very low pollutant emission when used in heating applications. Application of these heating devices has been limited, however, because of a lack of understanding of the fundamental controlling physical and chemical processes governing pulse combustors. An experimental research program has been initiated at Sandia National Laboratories to develop such insight. This paper reports the results of an experiment studying the effects of changing heat release and pressure pulsations on the fluid dynamics in the combustion chamber of a square pulse combustor. Using a two-color laser Doppler velocimeter (LDV) as a diagnostic tool, this study indicates that the fluid dynamics in the combustion chamber are strongly affected by pressure pulsations and are weakly affected by a change in the heat release rate. Author

A85-20925

OXIDATION AND STABILIZATION OF JET FUELS [OKISLENIE I STABILIZATSIYA REAKTIVNYKH TOPLIV]

E. T. DENISOV and G. I. KOVALEV Moscow, Izdatel'stvo Khimii, 1983, 270 p. In Russian. refs

The principal types of modern jet fuels are briefly reviewed, and problems associated with the oxidation of fuels during storage and use and the need for their stabilization are discussed. In particular, attention is given to the kinetics and mechanisms of the liquid-phase oxidation of hydrocarbons, kinetic methods of evaluating fuel oxidability, the mechanisms of oxidation inhibition, and the catalytic and inhibiting effects of structural materials on the oxidation of jet fuels. The relationship between the oxidability of fuels and their service-related properties is examined, and the efficiency of various oxidation inhibitors is assessed. V.L.

A85-21376

COMPOSITE STRUCTURES; PROCEEDINGS OF THE NATIONAL SPECIALISTS MEETING, PHILADELPHIA, PA, MARCH 23-25, 1983

Meeting sponsored by the American Helicopter Society. Washington, DC, American Helicopter Society, 1984, 335 p. For individual items see A85-21377 to A85-21398.

The present conference considers the design, fabrication and verification of a composite 'flexbeam' tail rotor, the development of a graphite/polyimide composite transmission housing, ground

test experience with large composite structures for commercial transport helicopters, advanced composite joints and fittings for primary structural components, the crashworthiness of helicopter composite structures, a flexible matrix composite hingeless rotor system, and recent filament-winding resin developments. Also discussed are the properties and advantages of Kevlar fiber reinforcement in airframe composites, the energy absorption characteristics of reinforced plastic tubes and composite materials, composite prototype and experimental aircraft, and the mechanical properties of magnawave glass/epoxy composites. O.C.

A85-21380

DEVELOPMENT OF A GRAPHITE/POLYIMIDE COMPOSITE TRANSMISSION HOUSING

J. W. LENSKE, JR. (Boeing Vertol Co., Philadelphia, PA) IN: *Composite structures; Proceedings of the National Specialists' Meeting, Philadelphia, PA, March 23-25, 1983. Washington, DC, American Helicopter Society, 1984, 11 p.* Army-sponsored research. refs

Attention is given to the results of a development effort encompassing the design, fabrication, and testing of a high modulus composite transmission housing which will reduce helicopter mechanical drive system weight and cost while improving reliability and system performance. The composite transmission housing includes among its advantages corrosion resistance, thermal stability, and exceptional specific strength and stiffness by comparison to conventional cast magnesium housings. A filament winding fabrication procedure was selected to minimize production costs through the elimination of hand layups, multiple cure cycles, and secondary bonds. O.C.

A85-21389

FLEXIBLE MATRIX COMPOSITES APPLIED TO BEARINGLESS ROTOR SYSTEMS

A. J. HANNIBAL, B. P. GUPTA, J. A. AVILA, and C. H. PARR (Lord Corp., Mechanical Group, Erie, PA) IN: *Composite structures; Proceedings of the National Specialists' Meeting, Philadelphia, PA, March 23-25, 1983. Washington, DC, American Helicopter Society, 1984, 34 p.* refs

A new composite structure in which the typical epoxy matrix is replaced by an elastomer is introduced. Some of its properties, particularly its elastic constants, are discussed in terms of laminate angle, constituent properties and fiber fraction. Unidirectional flexible matrix composites are applied to the requirements of a bearingless rotor flexure. This is done by assessing load-deflection characteristics and strengths of test coupons in critical loading modes. Preliminary results indicate a short, lightweight, flexible matrix composite flexure is feasible. Flexible matrix composites are also applied to a pitch control tube of a typical 3000-kg helicopter. A full scale prototype was fabricated and tested both statically and dynamically. It endured 50 x 10 to the 6th cycles of combined bending and torsion loads with only a modest loss of properties. Author

A85-21390

UTILIZATION OF ANALYTICAL EQUIPMENT IN DESIGN AND PROCESS PROBLEMS SOLUTION AND FAILURE ANALYSIS OF COMPOSITES

V. F. MAZZIO, R. R. IGNATUK, and H. R. LUZETSKY (Boeing Vertol Co., Philadelphia, PA) IN: *Composite structures; Proceedings of the National Specialists' Meeting, Philadelphia, PA, March 23-25, 1983. Washington, DC, American Helicopter Society, 1984, 9 p.*

The static and fatigue properties of epoxy/high strain graphite systems suitable for use in aircraft primary structures are presented, with attention to effects due to stress/strain, on the one hand, and those due to the surface and failure mechanism characteristics of the fibers, on the other. The results obtained for these high strain composite systems were compared to those for conventional graphite/epoxy. SEM and TEM were used to determine surface effects and evaluate failure mechanisms in tests conducted in 90-deg tension, compression, short beam shear, and in-plane shear.

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Excellent property improvements are noted for the high strain composite over standard materials. O.C.

A85-21392

KEVLAR ARAMID FIBERS VS OTHER FIBERS FOR REINFORCEMENT OF COMPOSITE STRUCTURES

P. R. LANGSTON (Du Pont de Nemours and Co., Wilmington, DE) IN: Composite structures; Proceedings of the National Specialists' Meeting, Philadelphia, PA, March 23-25, 1983. Washington, DC, American Helicopter Society, 1984, 22 p.

The physicomaterial properties of Kevlar 29 and Kevlar 49 fibers are reviewed, and the properties of Kevlar-reinforced composites are compared with those of other materials, such as graphite/epoxy, fiberglass/epoxy, boron/epoxy, cast iron, stainless steel, and aluminum. The properties discussed include tensile strength, specific modulus, flexural and compressive behavior, vibration dampening, fatigue strength, moisture pickup, and resistance to impact damage. The uses of Kevlar-reinforced composites in aerospace and aircraft structures are then examined. V.L.

A85-21393

ENERGY ABSORBING QUALITIES OF FIBER REINFORCED PLASTIC TUBES

C. M. KINDERVATER (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Stuttgart, West Germany) IN: Composite structures; Proceedings of the National Specialists' Meeting, Philadelphia, PA, March 23-25, 1983. Washington, DC, American Helicopter Society, 1984, 14 p. refs

The fulfillment of crashworthiness requirements in helicopter composite primary structures has prompted the present parametric study of composite tubes. The investigation ranged over matrix/fiber material variations, the influence of foam fillers, different fiber orientations, and various failure-triggering mechanisms. Attention is given to axial crushing under quasi-static and impact loading. Typical load deflection curves and failure modes are presented, together with such performance indicators as specific energy, energy dissipation density, stroke efficiency, load uniformity, and crush stress. Results are correlated to the energy absorption performance of other structures, such as aluminum and paper honeycomb and thin walled steel and aluminum cylinders. O.C.

A85-21482

V-378A, A NEW MODIFIED BISMALIMIDE MATRIX RESIN FOR HIGH MODULUS GRAPHITE

S. W. STREET (United States Polymeric, HITCO Materials Div., Santa Ana, CA) IN: Polyimides: Synthesis, characterization, and applications. Volume 1. New York, Plenum Press, 1984, p. 77-98.

The characteristics of V-378A, a new modified bismaleimide matrix resin for high-modulus graphite, are discussed. The prepreg properties, lay-up and cure properties, mechanical and physical properties, and effects of prepreg aging, are described. The applications of V-378A are summarized. The resin exhibits significant advantages over previously available bismaleimides and 350 F curing epoxy resins. Its T_g is in excess of 700 F, it has excellent tack at ambient temperatures, and it is available at prepreg resin solids contents as low as 30 percent for 'net' resin cures. It can be cured under standard low autoclave pressure of 100 psi and temperatures of 350 F. It offers easy, epoxylike processing characteristics with no volatile condensation products given off during cure, as well as significant superior high-temperature strength retention after severe humidity aging. C.D.

A85-21483* National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

A THERMOPLASTIC POLYIMIDESULFONE

T. L. ST. CLAIR (NASA, Langley Research Center, Hampton, VA) and D. A. YAMAKI (NASA, Langley Research Center, Hampton, VA; Mobil Research and Development Corp., Paulsboro, NJ) IN: Polyimides: Synthesis, characterization, and applications. Volume 1. New York, Plenum Press, 1984, p. 99-116. Previously announced in STAR as N83-14273. refs

A polymer system has been prepared which has the excellent thermoplastic properties generally associated with polysulfones, and the solvent resistance and thermal stability of aromatic polyimides. This material, with improved processability over the base polyimide, can be processed in the 260-325 C range in such a manner as to yield high quality, tough unfilled moldings; strong, high-temperature-resistant adhesive bonds; and well consolidated, graphite-fiber-reinforced moldings (composites). The unfilled moldings have physical properties that are similar to aromatic polysulfones which demonstrates the potential as an engineering thermoplastic. The adhesive bonds exhibit excellent retention of initial strength levels even after thermal aging for 5000 hours at 232 C. The graphite-fiber-reinforced moldings have mechanical properties which makes this polymer attractive for the fabrication of structural composites. Author

A85-21520* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

PMR POLYIMIDE COMPOSITES FOR AEROSPACE APPLICATIONS

T. T. SERAFINI (NASA, Lewis Research Center, Cleveland, OH) IN: Polyimides: Synthesis, characterization, and applications. Volume 2. New York, Plenum Press, 1984, p. 957-975. refs

A novel class of addition-type polyimides has been developed in response to the need for high temperature polymers with improved processability. The new plastic materials are known as PMR (for in situ polymerization of monomer reactants) polyimides. The highly processable PMR polyimides have made it possible to realize much of the potential of high temperature resistant polymers. Monomer reactant combinations for several PMR polyimides have been identified. The present investigation is concerned with a review of the current status of PMR polyimides. Attention is given to details of PMR polyimide chemistry, the processing of composites and their properties, and aerospace applications of PMR-15 polyimide composites. G.R.

A85-21527

POLYIMIDE PROTECTIVE COATINGS FOR 700 DEG SERVICE

R. J. JONES, G. E. CHANG, S. H. POWELL, and H. E. GREEN (TRW, Inc., TRW Energy Development Group, Redondo Beach, CA) IN: Polyimides: Synthesis, characterization, and applications. Volume 2. New York, Plenum Press, 1984, p. 1117-1137. refs

It has been discovered that partially fluorinated polyimide resins prepared from 2,2-bis(4-(4-aminophenoxy)-phenyl)hexafluoropropane (4-BDAF) possess great potential for long term service in highly oxidative environments at temperatures up to and including 700 F. The new class of polyimides shows promise for use in applications involving advanced aircraft, engines, and missile designs in which higher temperatures are reached. The present investigation is concerned with the results of initial coating product application studies. Attention is given to initial polyimide matrix resin studies and polyimide coating studies. It is concluded that the resins are amenable to a practical spray coating application technique. The resins are suitable for use as an oxidative barrier and/or corrosion inhibiting coating at temperatures up to a minimum of 700 F. G.R.

A85-21650* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

MICROSTRUCTURAL DEVELOPMENT OF PROTECTIVE AL₂O₃ SCALES

J. L. SMIALEK (NASA, Lewis Research Center, Cleveland, OH) IN: Electron Microscopy Society of America, Annual Meeting, 42nd, Detroit, MI, August 13-17, 1984. San Francisco, San Francisco Press, Inc., 1984, p. 594-597. refs

Microstructural characteristics of Al₂O₃ scales grown as protective coatings on NiCrAl alloys used in jet engines are described. The alloys were pure or doped with 0.3 percent Zr or Y and oxidized in 1 atm air at 1100 C for 0.1, 1 or 20.0 hr. The scales were then examined under a microscope. Transient epitaxial scales, formed during the 0.1 hr treatment and containing Ni, Cr and Al, consisted of a mosaic of subgrains and precipitates of different phases. The Y and Zr dopants had no effect on the nucleation site locations. The appearance of intergranular porosity at 0.1 hr was exacerbated after the 1 hr treatment. A bimodal void distribution appeared after 20 hr, when no porosity was evident. The detection of local areas of preferred orientation is taken as a spur to further studies of scale growth to gain control of the grain size or even to produce single crystal scales. M.S.K.

A85-21863#

SWIRLING FLOW IN A RESEARCH COMBUSTOR

J. I. RAMOS and H. T. SOMER (Carnegie-Mellon University, Pittsburgh, PA) AIAA Journal (ISSN 0001-1452), vol. 23, Feb. 1985, p. 241-248. Research supported by the Ford Motor Co. Previously cited in issue 05, p. 612, Accession no. A83-16644. refs

(Contract N00014-80-C-0400)

N85-15739# Motoren- und Turbinen-Union Muenchen G.m.b.H. (West Germany). Materials Lab.

COMPARISON BETWEEN THE PROPERTIES OF CONVENTIONAL WROUGHT AND POWDER METALLURGICAL ALLOYS FOR TURBINE DISC APPLICATIONS

G. W. KOENIG /In AGARD Eng. Cyclic Durability by Analysis and Testing 11 p Sep. 1984 refs
Avail: NTIS HC A12/MF A01

Mechanical properties of powder-metallurgical nickel-base superalloys (e.g., U700PM; Rene 95) were evaluated in order to predict the behavior of advanced aero-engine discs in comparison with conventional wrought nickel-base (e.g., Waspaloy; IN 718) discs. The assessment includes tensile strength, crack initiation and propagation fatigue life as well as the influence of mean stress. Special emphasis was put on the question about the scatter in fatigue lives resulting from defects in the material (e.g., oxide inclusions) and on the surface (e.g., grooves). The tolerance with respect to these defects was estimated on the basis of fracture mechanics methods. The potential of advanced nickel-base superalloys with respect to static strength and fatigue life is superior to that of currently used conventional wrought disc materials. It is shown that the most important requirement for the use of this fatigue potential is a high quality standard which limits the maximum size of defects both in the material and on the surface. The now available knowledge of the variable influencing the reliability of disc materials enables an optimization to obtain improved service behavior. Furthermore, the strength and quality of materials as well as the manufacturing process can be fitted to the requirements of each type of component. R.J.F.

N85-15831# Research Inst. of National Defence, Stockholm (Sweden). Dept. 2.

IMPRESSIONS FROM A STUDY TOUR IN FINLAND CONCERNING FIBER REINFORCED PLASTICS, JUNE 1984

F. LARSSON Sep. 1984 11 p refs In SWEDISH; ENGLISH summary
(FOA-C-20552-D2(E4,F9); ISSN-0347-3694) Avail: NTIS HC A02/MF A01

The use of fiber reinforced plastics in high performance applications is outlined, including light plastic structures for aeronautical wings, sandwich structures, autoclaves and quenching

ovens, and thermoplastic resins. Carbon and glass fibers, pultrusion combined with filament winding, ductility determination for plastic structures, and corrosion resistance are also discussed.

Author (ESA)

N85-15919# Michigan Univ., Ann Arbor. Dept. of Mechanical Engineering.

SOME CHARACTERISTICS OF AUTOMOTIVE GASOLINES AND THEIR PERFORMANCE IN A LIGHT AIRCRAFT ENGINE Final Report, Oct. 1982 - Mar. 1984

K. M. MORRISON, N. W. SUNG, and D. J. PATTERSON Atlantic City FAA Nov. 1984 101 p refs
(Contract DOT-FA79NA-6083)

(FAA-CT-84-12) Avail: NTIS HC A06/MF A01

The primary purpose of this extensive test effort was to observe real-time operational performance characteristics associated with automotive grade fuel utilized by piston engine powered light general aviation aircraft. In fulfillment of this effort, baseline engine operations were established with 100LL aviation grade fuel followed by four blends of automotive grade fuel. A comprehensive sea-level - static test cell/flight test data collection and evaluation effort was conducted to review operational characteristics of a carbureted light aircraft piston engine as related to fuel volatility, fuel temperature, and fuel system pressure. Presented herein are results, data, and conclusions drawn from test cell engine operation as well as flight test operation on 100LL aviation grade fuel and various blends of automotive grade fuel. Sea-level-static test cell engine operations were conducted utilizing an AVCO Lycoming O-320 engine connected to an eddy current dynamometer which facilitated data collection under various engine load conditions. Test cell instrumentation was utilized to obtain operational data (temperatures, pressures, flow rates, torque, horsepower, exhaust emissions, etc.) from idle through cruise to maximum power with fuel grades having Reid vapor pressures of 6.7, 8.0, 11.7, 14.0, and 14.4. Author

N85-15920# Boeing Military Airplane Development, Seattle, Wash.

AIRCRAFT WING FUEL TANK ENVIRONMENTAL SIMULATOR TESTS FOR EVALUATION OF ANTIMISTING FUELS Final Report, Sep. 1982 - Aug. 1984

P. M. MCCONNELL, F. F. TOLLE, and H. K. MEHTA Atlantic City FAA Oct. 1984 107 p refs
(Contract DTFA03-83-C-00038)

(FAA-CT-84-15) Avail: NTIS HC A06/MF A01

The low temperature performance of antimisting kerosene (AMK) in airframe fuel systems and in certain engine fuel system components was studied and compared to Jet A fuel. Water vapor ingested into fuel tanks during simulation of repeated descents through clouds and rain had little effect on AMK. AMK retained antimisting properties during exposure to severe environmental flight simulations. Jet pump and boost pump operation had no discernable effect on AMK flammability. Jet pump performance with AMK was adversely affected. Main fuel boost pumps required up to 18 percent more power with AMK than with Jet A, and suction feed performance was lower with ambient and -20 C, but better than Jet A at -40 C. Boost pump performance was not affected by gel formations produced at low temperatures by the vapor removal return flow shearing of AMK. Aerodynamic heating and cooling of AMK in the fuel tank was similar to Jet A. A high pressure pump and needle valve used to degrade the AMK was inadequate, resulting in filter bypass at low temperatures. Author

N85-15921# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Systems and Logistics.

DISTRIBUTION AND STORAGE OF AVIATION TURBINE FUEL FOR MILITARY OPERATIONS IN NORTHERN AUSTRALIA M.S. Thesis

D. A. WHITTY Sep. 1984 141 p
(AD-A147180; AD-E850744; AFIT/GLM/LSM/84S-63) Avail: NTIS HC A07/MF A01 CSCL 21D

In northern Australia, prospective economic development is unlikely to create a distributed network of aviation turbine fuel

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storages sufficient to support Australian Defence Force operations in an emergency, and Defence investment in fuel storage facilities and distribution resources might be required. This thesis project was an effort to identify the key relationships in the operational fuels system, and to create a decision support system capable of indicating broad relationships and tradeoffs between decision variables. To answer investigative questions arising from a broad system review, relevant literature was examined, indicating a need to focus on the distribution system with five key elements: (1) demand, (2) bulk seaboard storage facilities, (3) base storage, (4) transport resources, and (5) transport represent system dynamics for distribution from bulk to base storage. Subject to correcting of input statistics, the results could be used to inform Defence decisions on facilities construction, and investment in transport resources. With recommended enhancements, the model could potentially be used to inform Defence contributions to national and international policy considerations. GRA

N85-15922# Pratt and Whitney Aircraft, West Palm Beach, Fla. Government Products Div.

EVALUATION OF JET FUEL DEPOSIT KINETICS. LOT 4 Final Report, Mar. 1983 - Mar. 1984

W. J. PURVIS and R. J. MEEHAN Mar. 1984 48 p

(Contract N00140-80-C-0097)

(AD-A147196; PWA-FR-17658; NAPC-PE-107C) Avail: NTIS HC A03/MF A01 CSCL 21D

Four selected JP-5 type Navy jet fuels were investigated with regard to their rate of thermally induced deposition using two analytical techniques. A modified research Jet Fuel Thermal Oxidation Tester (JFTOT), using a quartz-enclosed heater section in combination with a photosensitive detector, was to monitor the buildup of thermally induced fuel deposits. Concurrent with the JFTOT, tests were conducted using the Experimental Coking Apparatus (ECA) in order to establish comparable deposition rate data. The resultant Arrhenius analyses have contributed to understanding the impact of an invariant oxygen concentration on the specific fuel deposition rate. An attempt to measure the hydrocarbon peroxide associated with each fuel and the buildup of organo-peroxide with fuel temperature was inconclusive due to the variation in peroxide potential analysis (ASTM D-3703). Originator-supplied key words include: Coking. GRA

N85-15931# Joint Publications Research Service, Arlington, Va. **ALL-COMPOSITE AIRBUS EMPENNAGE Abstract Only**

In its West Europe Rept.: Sci. and Technol. (JPRS-WST-84-039) p 4 18 Dec. 1984 Transl. into ENGLISH from Composites et Nouveaux Mater. (Paris), Sep. 1984 p 6

Avail: NTIS HC A04/MF A01

An all-composite Airbus empennage with a framework built entirely out of carbon fibers and epoxy resin in the form of two pre-impregnated fibredux units is discussed. It is suggested that the operating costs of a commercial airplane could be lowered without reducing its flight safety, by using support structures made of high performance composites. With 20% less weight, composite frames should be fully interchangeable with metal frames and meet the same navigability specifications. Their external geometry and attachment points to the fuselage, leading edge, and rudder should therefore be identical to those of metal structures. Moreover, their mass production has to be automated for economic reasons. When these requirements are met, five planes will be equipped with a composite empennage framework for flight tests. E.A.K.

N85-17048*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

ADVANCES IN COMPOSITES TECHNOLOGY

D. R. TENNEY and H. B. DEXTER Jan. 1985 33 p refs

(NASA-TM-86353; NAS 1.15:86353) Avail: NTIS HC A03/MF A01 CSCL 11D

A significant level of research is currently focused on the development of tough resins and high strain fibers in an effort to gain improved damage tolerance. Moderate success has been achieved with the development of new resins such as PEEK and additional improvements look promising with new thermoplastic

resins. Development of innovative material forms such as 2-D and 3-D woven fabrics and braided structural subelements is also expected to improve damage tolerance and durability of composite hardware. The new thrust in composites is to develop low cost manufacturing and design concepts to lower the cost of composite hardware. Processes being examined include automated material placement, filament winding, pultrusion, and thermoforming. The factory of the future will likely incorporate extensive automation in all aspects of manufacturing composite components. B.W.

N85-17049*# Lockheed-California Co., Burbank.

FLIGHT SERVICE EVALUATION OF ADVANCED COMPOSITE AILERONS ON THE L-1011 TRANSPORT AIRCRAFT Annual Flight Service Report

R. H. STONE Dec. 1984 10 p refs

(Contract NAS1-15069)

(NASA-CR-172483; NAS 1.26:172483; LR-30774; AFSR-2)

Avail: NTIS HC A02/MF A01 CSCL 11D

A flight service evaluation of composite inboard ailerons on the L-1011 is discussed. This is the second annual report of the maintenance evaluation program, and covers the period from July 1983 when the first yearly inspections were completed, through July 1984. Four shipsets of graphite/epoxy composite ailerons were installed on L-1011 aircraft for this maintenance evaluation program. These include two Delta aircraft and two TWA aircraft. A fifth shipset of composite ailerons were installed in 1980 on Lockheed's flight test L-1011. A visual inspection was also conducted on these components. No visible damage was observed on any of the composite ailerons, and no maintenance action has occurred on any of the composite parts except for repainting of areas with paint loss. Flight hours on the airline components at the time of inspection ranged from 6318 to 6989 hours, after approximately 2 years of service. B.W.

N85-17057# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).

COMPOSITE STRUCTURE REPAIR, ADDENDUM

Loughton, England Aug. 1984 26 p refs Presented at the 58th Meeting of the Struct. and Mater. Panel, Sienna, Italy, 2-6 Apr. 1984 Addendum to AGARD-R-716; N84-31300

(AGARD-R-716-ADD; ISBN-92-835-1476-9) Avail: NTIS HC A03/MF A01

Programs are presented in which bonded and bolted composite repair techniques were validated. The repair of specific military and commercial aircraft components is addressed. Composite repair of flat laminates, integral stiffened panels, and honeycomb sandwich structures on aircraft is discussed.

N85-17058# Naval Air Development Center, Warminster, Pa. **REPAIR OF COMPOSITES**

T. M. DONNELLAN, E. L. ROSENZWEIG, R. E. TRABOCCO, and J. G. WILLIAMS (Aeronautical Research Labs., Melbourne) *In* AGARD Composite Struct. Repair, Addendum 10 p Aug. 1984 refs

Avail: NTIS HC A03/MF A01

Developments in composite repair technology are discussed. The planned use of composites in primary aircraft structure has necessitated the development of a specialized repair technology. The types of damage seen in composites differs from conventional materials. Delamination is the most serious composite defect since it can exist without causing surface damage. The two techniques used to repair composites are bonded and bolted approaches. A number of programs have been performed which have evaluated repair techniques under simulated operating conditions. Programs are discussed in which bonded and bolted repair techniques were validated. Generic repair development programs are described in which the repairs were performed with equipment and techniques possible in the service environment. The results of these studies show that the repairs restored the component structural integrity. Repair programs on specific military and commercial aircraft are also described. The components studied included an AHI rotor blade, a S-3A spoiler and a L-1011 fin. R.S.F.

N85-17059# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (West Germany).

COMPOSITE REPAIR OF AIRCRAFT STRUCTURES

J. W. VILSMEIER /in AGARD Composite Struct. Repair, Addendum 9 p Aug. 1984

Avail: NTIS HC A03/MF A01

The repair of composite and metallic aircraft structures with composite materials has become a matter of world wide interest and activity. Activities in the field of composite repair of flat laminates, honeycomb sandwich structures, and integral stiffened panels are presented. Composite repair problems, aircraft battle damage repair, bonding on wet laminates, environmental effects, and problems associated with nondestructive testing of repaired structures and repair of joints are discussed. R.S.F.

N85-17077# Department of the Air Force, Washington, D.C.
HEATER BLOCK ASSEMBLY FOR USE IN THERMAL OXIDATION TESTING OF JET FUEL Patent Application

R. A. HARVEY, inventor (to Air Force) 19 Sep. 1984 12 p (AD-D011430; US-PATENT-APPL-SN-651983) Avail: NTIS HC A02/MF A01 CSCL 21B

A heater block assembly for a jet fuel thermal oxidation test apparatus has back and front plates with a heater plate clamped therebetween. The heater plate has a flat surface which faces the front plate, while the front plate has a raised ledge with a channel formed therein which faces the flat surface of the heater plate. Also, inlet and outlet openings to opposite ends of the channel are formed through the front plate. When the back and front plates are clamped together with the heater plate therebetween the flat surface of the heater plate and the channel in the front plate together define a fuel sample flow passage. Thus, the fuel sample undergoing test is pumped through the inlet on the front plate into the flow passage where it flows along and in contact with the flat surface and then out through the outlet on the front plate. Heating rods disposed in the back plate raise the temperature of the back plate and thereby the heater plate and fuel sample, causing thermal decomposition deposits from the heated fuel to form on the flat surface of the heater plate. Author (GRA)

N85-17152# Rolls-Royce Ltd., Derby (England).
ROLLS-ROYCE EXPERIENCE WITH THERMAL BARRIER COATINGS

A. BENNETT 1 Aug. 1984 7 p Presented at British Ceramic Soc. Basic Sci. Section Meeting, London, 10-21 Dec. 1983 (PNR-90222) Avail: NTIS HC A02/MF A01

Technical and economic justifications for the use of thermal barrier coatings in aero engines are outlined. Zirconia-based ceramic coating materials are reviewed. The use of metallic and cermet bonding coats is described, particularly oxidation related failure mechanisms. Diagnostic analyses to explain failure mechanisms related to the stresses and strains encountered in major engine cycles are presented. This approach is valuable in clarifying the failure mechanisms and directing research towards effective material and processing improvements. Author (ESA)

N85-17153# SRI International Corp., Menlo Park, Calif.
ANALYSIS OF MIDDLE DISTILLATE FUELS BY HIGH RESOLUTION FIELD IONIZATION MASS SPECTROMETRY Annual Report, 1 Jun. 1982 - 31 Aug. 1984

R. MALHOTRA, M. J. COGGIOLA, S. E. YOUNG, D. TSE, and S. E. BUTTRILL, JR. 29 Oct. 1984 40 p (Contract N00014-81-K-2032; F65-511) (AD-A147724) Avail: NTIS HC A03/MF A01 CSCL 21D

A method for the rapid and detailed chemical characterization of distillate fuels has been developed using high resolution field ionization mass spectrometric (HR-FIMS) techniques. A vintage AEI MS-9 mass spectrometer has been modified to house a volcano-style field ionizer and has been equipped with a high-temperature batch inlet system. Field ionization is particularly useful in this regard because it produces only molecular ions for most compounds and because different compound types do not differ in their ionization efficiencies by more than a factor of four.

The mass spectrometer is operated at a resolution of 3000, which is adequate to resolve all the different types of hydrocarbons likely to be present in the fuel sample. Software has been written to present the mass spectrum intensities in a matrix where the various columns represent the different z-series of the hydrocarbons and the rows represent the number of carbon atoms in any given component. Analysis of a stable and an unstable jet fuel showed that the unstable fuel had a substantially higher naphthalene content. GRA

N85-17155# Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Chemistry.

GC-FTIR (FOURIER TRANSFORM INFRARED SPECTROMETRY) OF JET FUELS Final Report, 15 Jul. 1982 - 15 Aug. 1983

J. R. COOPER and L. T. TAYLOR Feb. 1984 156 p

(Contract F33615-82-C-2258)

(AD-A148272; AFWAL-TR-84-2007) Avail: NTIS HC A08/MF A01 CSCL 07D

The successful interfacing and utilization of fused silica capability gas chromatography (GC) columns with Fourier transform infrared spectrometry (FTIR) can introduce difficulties not usually encountered with lower efficiency (higher capacity) GC columns. Recognition of these difficulties, however, can lead to refinement of a GC-FTIR detection system which can analyze complete samples with low nanogram detection limits. Chromatography and spectrometric considerations include lightpipe temperature, choice of same introduction, column concentration dynamic range capability, infrared data acquisition rate and spectral S/N ratio. These parameters as they relate to capability GC-FTIR method development are discussed. GC-FTIR identification limits for sixteen model compounds which represent both polar and non-polar functionalities have been established employing optimized chromatographic-spectrometric parameters for complex mixture analysis. GRA

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ENGINEERING

Includes engineering (general); communications; electronics and electrical engineering; fluid mechanics and heat transfer; instrumentation and photography; lasers and masers; mechanical engineering; quality assurance and reliability; and structural mechanics.

A85-19491*# United Technologies Corp., East Hartford, Conn.
CALCULATION OF CONFINED SWIRLING FLOWS

G. J. STURGESS and S. A. SYED (United Technologies Corp., Engineering Div., East Hartford, CT) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 16 p. refs (Contract NAS3-235924; NAS3-23686) (AIAA PAPER 85-0060)

Swirling jets are an important constituent flow of many types of combustion equipment. Flame size, shape, stability and combustion intensity are all favorably influenced by swirling some portion of the incoming air with the fuel. Fluid dynamics computer codes are being developed for the mathematical simulation of flows in practical combustors. It is important that these codes have the ability to accurately and reliably calculate swirling flows. Turbulent flow calculations with swirl can be inaccurate due to at least three major reasons: limitations of the turbulence modeling used, incorrect or inadequate specifications of inlet boundary conditions, and, error introduced through the numerics. These sources of error are described, and examples provided of each. The state-of-the-art in such calculations is reviewed. The controlling character of current numerics is demonstrated, and it is concluded that as a first priority, better numerics must be arrived at, and that an improved understanding of the discharge flow from swirl generators is essential as a second priority. When these priorities

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are satisfied an improved turbulence model is desirable. It is also concluded that an improved understanding of swirl-induced recirculation would be an asset. Author

A85-19520#

FLOW VISUALIZATION OF HIGH ANGLE OF ATTACK VORTEX WAKE STRUCTURES

R. C. NELSON (Notre Dame, University, Notre Dame, IN) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 11 p. refs (AIAA PAPER 85-0102)

Various flow visualization techniques and associated data on high angle of attack (AOA) aerodynamics are surveyed. Schlieren photography records density gradients in the flowfield when incident light is refracted by the gas to different degrees due to density variations. Three-dimensional vortex trajectory data are obtained by taking the photographs in two mutually orthogonal planes. Vortices and shocks are revealed by pumping a mist into the test channel flow and illuminating the resulting artificial fog with a thin sheet light beam, a technique called vapor screen photography. Low speed flow features can be recorded by introducing dye tracers into the mist. Substitution of smoke for the fog and using laser sheet light as the luminance source comprises the smoke streakline method, which yields images for characterizing vortex behavior and evolution. M.S.K.

A85-19575#

COMPUTATION OF RECIRCULATING COMPRESSIBLE FLOW IN AXISYMMETRIC GEOMETRIES

K. M. ISAAC (Missouri-Rolla, University, Rolla, MO) and A. S. NEJAD (USAF, Aero Propulsion Laboratory, Dayton, OH) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 9 p. refs (Contract F49620-82-C-0035) (AIAA PAPER 85-0185)

A computational study of compressible, turbulent, recirculating flow in axisymmetric geometries is reported in this paper. The SIMPLE algorithm was used in the differencing scheme and the k-epsilon model for turbulence was used for turbulence closure. Special attention was given to the specification of the boundary conditions. The study revealed the significant influence of the boundary conditions on the solution. The eddy length scale at the inlet to the solution domain was the most uncertain parameter in the specification of the boundary conditions. The predictions were compared with the recent data based on laser velocimetry; the two are seen to be in good agreement. The present study underscores the need to have a more reliable means of specifying the inlet boundary conditions for the k-epsilon turbulence model. Author

A85-19706#

EVALUATION OF LOW REYNOLDS NUMBER TURBULENCE MODELS FOR ATTACHED AND SEPARATED FLOWS

A. SUGAVANAM (Lockheed-Georgia Co., Marietta, GA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 12 p. refs (AIAA PAPER 85-0375)

Time-averaged Navier-Stokes and boundary layer computations have been performed to study the algebraic and the two-equation turbulence models in complex flows. Special attention is paid to the near-wall behavior of the low Reynolds number turbulence models of Jones-Launders and Chien. The mean flow and turbulence predictions are compared with reliable experimental data. Both the algebraic and the two-equation turbulence models are found to predict the mean flow characteristics very well. However, the Chien k-epsilon model is found to perform better than other models in predicting turbulence characteristics. Also this model is found to have fewer numerical problems compared to the other two-equation models included in the study. Author

A85-19735#

ANALYSIS AND TESTING OF THE DIAMOND ONE WING ANTI-ICING SYSTEM

K. E. YEOMAN (KEY Industries Corp., San Antonio, TX) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 9 p. refs (AIAA PAPER 85-0414)

The Diamond One wing leading edge is protected against ice accretions by a bleed air anti-icing system. Three cross-sections selected for computer modeling considered the thermal mechanisms of convection, conduction, evaporation and sensible heating of impinged and runback water. With an instrumented aircraft, the model was refined using dry air and above freezing cloud flight test data. The refined model was exercised for wing surface temperature predictions for six critical icing conditions and found safe for natural icing flight testing. Measured natural icing test data was then inserted into the model to compare predicted vs. measured temperatures. Correlation was achieved and the system was accepted by FAA as safe for flight into known icing conditions. Author

A85-19754#

FREE SURFACE SCARS AND STRIATIONS DUE TO TRAILING VORTICES GENERATED BY A SUBMERGED LIFTING SURFACE

T. SARPKEYA (U.S. Naval Postgraduate School, Monterey, CA) and D. O. HENDERSON, JR. (U.S. Naval Postgraduate School, Monterey, CA; U.S. Navy, Charleston Naval Shipyard, Charleston, SC) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 10 p. refs (AIAA PAPER 85-0445)

The characteristics of the surface signatures (scars and striations) resulting from the interaction of the ascending trailing vortices with the free surface have been investigated. The vortices were generated by towing horizontally various lifting surfaces (delta wings and rectangular foils of different shape and aspect ratio) well below the free surface at prescribed speeds, depths, and negative angles of attack. The evolution of each type of surface signature has been expressed in terms of the governing parameters such as the depth of generation, mutual induction velocity, and the initial spacing of the vortex pair. It has been shown that the surface signatures are created and driven by trailing vortices and vortex rings. Two turbulent vortex models have been used to predict the apparent circulation of the vortices and the observed characteristics of the scar tracks. Author

A85-19769#

MEASUREMENT OF ICE ACCRETION USING ULTRASONIC PULSE-ECHO TECHNIQUES

R. J. HANSMAN, JR. and M. S. KIRBY (MIT, Cambridge, MA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 8 p. (AIAA PAPER 85-0471)

Results of tests to measure ice thickness using ultrasonic pulse-echo technique are presented. Tests conducted on simulated glaze and rime ice, and ice crystals are described. Additional tests on glaze and rime ice samples formed in the Icing Research Tunnel at NASA Lewis are also described. The speed of propagation of the ultrasonic wave used for pulse-echo thickness measurement is found to be insensitive to the type of ice structure, and is determined to be 3.8 mm/microsec. An accuracy of + or - 0.5 mm is achieved for ice thickness measurement using this technique. Author

A85-19832

PRECALCULATION OF ROTATING STALL IN MULTISTAGE AXIAL COMPRESSORS [BEITRAG ZUR VORAUSBERECHNUNG DES ROTATING STALL IM MEHRSTUFIGEN AXIALVERDICHTER]

D. TANG Aachen, Rheinisch-Westfaelische Technische Hochschule, Fakultät fuer Maschinenwesen, Dr.-Ing. Dissertation, 1983, 93 p. In German. refs

The present investigation is concerned with the development of a nonlinear model for predicting rotating stall. Previously, the nonlinear model could only be employed in cases involving a single stage. An analysis of the effects found in cases involving several stages makes it possible to adapt this model for a precalculation of the rotating stall in a multistage compressor. The boundary conditions in the model developed by Takata and Nagano (1972) and in the model reported by Orner (1979) make it impossible to consider the effects of a use of several stages. In the current investigation, an 'interface' is used to consider the influence of adjacent stages. The obtained nonlinear model is employed in the case of a single-stage design and a two-stage design. It was found possible to calculate the important data, including the beginning of rotating stall, the rotational frequency of the stall cells, and the left branch of the characteristic. A basic problem in the case of a nonlinear model of the rotating stall is related to the continuous increase in the amplitude of the stall cells. G.R.

A85-19837

REFLECTOR ANTENNAS WITH DIRECTIONAL EFFECT IN THE NEAR-FIELD CHARACTERISTICS AND APPLICATIONS [REFLEKTORANTENNEN MIT RICHTWIRKUNG IM NAHFELD - EIGENSCHAFTEN UND ANWENDUNGEN]

W. HOLZ Stuttgart, Universitaet, Dr.-Ing. Dissertation, 1983, 112 p. In German. refs

The present investigation is concerned with the characteristics and applications of reflector antennas with a radiation field which is focused on a point in the antenna near field. Scalar diffraction theory is employed to study apertures with a spherical phase front and a convergence of the radiation in the focus. Particular attention is given to the radiation field of the rectangular and circular focusing aperture. The radiation field of elliptical reflectors is studied with the aid of a vectorial approximate calculation. An application area of focusing antennas related to position finding is considered, taking into account the antenna of a radar for monitoring an aircraft landing field. In this radar system, the considered objects are partly or entirely in the antenna near field. Applications related to antenna measurement techniques are also discussed, taking into account focusing in the case of a parabolic reflector and the computation of radiation patterns. G.R.

A85-19886

THE HYDRAULIC AND ELECTROHYDRAULIC ELEMENTS USED IN FLIGHT SIMULATORS [HYDRAULICKE A ELEKTROHYDRAULICKE PRVKY PRO STAVBU LETECKYCH SIMULATORU]

P. BERGMANN (TST, Rakovník, Czechoslovakia) Zpravodaj VZLU (ISSN 0044-5355), no. 5, 1984, p. 299-301. In Czech. refs

The advantages of using hydraulic and electrohydraulic components in flight simulators are reviewed. In particular, it is noted that hydraulic and electrohydraulic mechanisms afford simple implementation of rectilinear motion with high dynamic characteristics, simple overload protection, and high density of power transmission, providing for small size and weight. Data are presented on the components commercially available in Czechoslovakia that can be used in flight simulators. The principal trends in the development of hydraulic and electrohydraulic components abroad are reviewed. V.L.

A85-20232#

A METHOD FOR CALCULATING THE PERFORMANCE OF EJECTOR NOZZLES

H. QIAN, M. ZHANG, and G. YE Journal of Engineering Thermophysics, vol. 5, Feb. 1984, p. 47-50. In Chinese, with abstract in English.

The conventional assumption that secondary flow is a one-dimensional isentropic and that the pressure of both primary and secondary flow are equal has been modified in this paper. The pressure of primary and secondary is calculated by means of the relation between front and back parameters of the shock or Mach shock, and the ejector nozzle performance is determined using the equations between the inlet section and other characteristic sections. Calculation results of this paper have been verified by means of experimental data, and quite good agreement is obtained. Author

A85-20452

DETERMINATION OF THE OPTIMAL PARAMETERS OF AIRCRAFT STRUCTURAL ELEMENTS IN THE FORM OF SANDWICH PLATES AND SHALLOW SHELLS WITH A HONEYCOMB FILLER [OB OPREDELENII OPTIMAL'NYKH PARAMETROV ELEMENTOV AVIATIONNYKH KONSTRUKTSII TIPA TREKHSLOINNYKH PLASTIN I POLOGIKH OBOLOCHEK S SOTOVYM ZAPOLNITELEM]

A. IA. ALEKSANDROV and M. I. NAUMOVA IN: Current problems in aviation science and technology. Moscow, Izdatel'stvo Mashinostroenie, 1984, p. 4-14. In Russian. refs

Graphic and iterative methods are used to determine the minimum-weight parameters of sandwich plates and shallow shells with honeycomb filler under uniform longitudinal compression and uniform heating. The analysis takes into account the effect of initial fabrication-related defects on the structural strength. Results are presented for plates with D16AT alloy layers and for a cylindrical panel. B.J.

A85-20454

THEORY OF VIBRATION CONDUCTION AS A METHOD FOR CALCULATING THE VIBRATION OF COMPLEX STRUCTURES [TEORIYA VIBROPROVODNOSTI KAK METOD RASCHETA VIBRATSII SLOZHNYKH KONSTRUKTSII]

A. K. BELIAEV and V. A. PALMOV IN: Current problems in aviation science and technology. Moscow, Izdatel'stvo Mashinostroenie, 1984, p. 29-37. In Russian. refs

A vibration-conduction theory (VCT) is proposed which is a means to describe and analyze the high-frequency random vibration of complex dynamic objects (e.g., aircraft structures) by methods of heat-conduction theory. A differential equation of heat-conduction type is obtained, and methods for formulating the boundary and initial conditions are described. The parameters of the VCT are expressed through the mean mechanical characteristics of the object, e.g., the mean density, the mean stiffness, and the frequency-dependent parameter of vibration absorption by the structure. Temperature is represented as a linear function of the spectral densities of accelerations of points of the object in the direction of its orthotropy axes. The nonnegativity and uniqueness of the solution are proved. B.J.

A85-20459

CURRENT PROBLEMS IN THE THEORY OF PLATES AND SHELLS IN AIRCRAFT [SOVREMENNYE PROBLEMY TEORII PLASTINOK I OBOLOCHEK V LETATEL'NYKH APPARATAKH]

A. S. VOLMIR IN: Current problems in aviation science and technology. Moscow, Izdatel'stvo Mashinostroenie, 1984, p. 77-87. In Russian. refs

A survey is made of recent theoretical and experimental studies of plates and shells considered as elements of aircraft and their engines. Particular emphasis is placed on the application of finite-difference and finite-element methods, and attention is given to such examples as aircraft with large or small aspect-ratio wings, superelements for helicopter rotors, and the centrifugal wheel of a gas-turbine compressor. Also considered are problems of dynamic

stability and fracture mechanics. Finally, problems which will require study and solution in the 1980's and 1990's are discussed. B.J.

A85-20460

SELECTION OF RATIONAL MODELS IN THE OPTIMAL PLANNING OF AEROMECHANICAL EXPERIMENTS [VYBOR RATSIONAL'NYKH MODELEI V ZADACHAKH OPTIMAL'NOGO PLANIROVANIYA AEROMEKHANICHESKOGO EKSPERIMENTA]

G. L. GRODZOVSKII IN: Current problems in aviation science and technology. Moscow, Izdatel'stvo Mashinostroenie, 1984, p. 88-95. In Russian. refs

The paper describes an approach to the development of rational models for the statistical description of aeromechanical experiments involving balance measurements of aerodynamic forces and moments. The approach makes it possible to apply the maximum likelihood method, resulting in a rigorous solution to the inverse problem of mathematical statistics. B.J.

A85-20463

DESIGN OF LOAD-BEARING AIRCRAFT STRUCTURES [PROEKTIROVANIIE SILOVYKH SKHEM AVIATSIONNYKH KONSTRUKTSII]

V. A. KOMAROV IN: Current problems in aviation science and technology. Moscow, Izdatel'stvo Mashinostroenie, 1984, p. 114-129. In Russian. refs

A method for the computer-aided design of load-bearing structures is proposed which is based on the determination of the theoretically optimal structures using continuum models, followed by a graphic analysis of rational pathways of force transmission. Attention is given to the design characteristics of planar structures, wings, fuselages, and arbitrary three-dimensional elastic systems. The development of detailed finite-element methods is considered as the culminating stage in the design of the load-bearing structures. B.J.

A85-20472

AEROELASTIC STABILITY AND VIBRATION OF LAYERED PLATES AND CYLINDRICAL SHELLS [AEROUPRUGAIA USTOICHIVOST' I KOLEBANIYA SLOISTYKH PLASTIN I TSILINDRICHESKIKH OBOLOCHEK]

A. I. SMIRNOV IN: Current problems in aviation science and technology. Moscow, Izdatel'stvo Mashinostroenie, 1984, p. 190-197. In Russian. refs

Exact solutions have been obtained for boundary value problems concerning the vibration and supersonic flutter of sandwich plates and cylindrical shells. Results of parametric studies are presented which provide information on the effect of flow parameters, plate and shell material and geometry, median surface forces, and boundary conditions on the natural frequencies and modes of vibrations, both in vacuum and in gas flow. The mechanisms of flutter and divergence are discussed. V.L.

A85-20501

ADVANCES IN HEAT TRANSFER. VOLUME 16

J. P. HARTNETT, ED. (Illinois, University, Chicago, IL) and T. F. IRVINE, JR., ED. (New York, State University, Stony Brook, NY) Orlando, FL, Academic Press, Inc., 1984, 399 p. For individual items see A85-20502 to A85-20503.

The diffusion of turbulent buoyant jets is considered along with the boiling of multicomponent liquid mixtures, heat flow rates in saturated nucleate pool boiling, and a review of turbulent-boundary-layer heat transfer research at Stanford, 1958-1983. In connection with the boiling of multicomponent liquid mixtures, attention is given to the fundamentals of vapor-liquid phase equilibria, the inception of boiling, bubble growth, bubble departure, nucleate pool boiling heat transfer, prediction of nucleate boiling heat transfer coefficients, peak nucleate heat flux, film boiling, and convective boiling. A wide-ranging examination using reduced properties is conducted in the study of heat flow rates in saturated nucleate pool boiling. G.R.

A85-20800

ON THE EXCITATIONS DUE TO THE PERIODIC STRUCTURE OF TURBOMACHINES [UEBER DIE ERREGUNG INFOLGE DER PERIODISITAET VON TURBOMASCHINEN]

M. DUBAS (Sulzer-Escher Wyss AG, Zurich, Switzerland) Ingenieur-Archiv (ISSN 0020-1154), vol. 54, no. 6, 1984, p. 413-426. In German. refs

In the present paper, the excitation caused by the periodical character of the rotor and the stator of turbomachines of any kind is investigated. The basic assumption is that, each time a runner blade passes a guide vane, a radial, a tangential and an axial load are produced. With the help of three simple mathematical models, the forces and moments and especially their frequencies resulting from all these loads are determined. Depending on the position in time and space of each impulse and on the considered resultant, namely, that acting on the shaft, on a blade, or on the disk, these resultants have other properties. Furthermore, in the case of vibrations of shafts and disks, in addition to the known resonance condition, i.e., excitation frequency = natural frequency, an existence condition depending on the number of blades has to be taken into account. Author

A85-20828

OPTIMIZATION OF FLUTTER CHARACTERISTICS [OPTIMIZATSIYA FLATTERNYKH KHKARAKTERISTIK]

A. P. SEIRANIAN and A. V. SHARANUK (Akademiya Nauk SSSR, Institut Problem Mekhaniki, Moscow, USSR) Akademiya Nauk Armianskoi SSR, Izvestiya, Mekhanika (ISSN 0002-3051), vol. 37, no. 5, 1984, p. 38-51. In Russian. refs

Nonconservative elastic stability problems in discrete systems are considered. Expressions are obtained for the derivatives of the critical stability parameters by means of a system of coupled equations. A number of problems connected with the optimization of flutter characteristics in a low aspect ratio wing in a gas flow are discussed as examples. Numerical results are presented. I.H.

A85-20852#

APPLICATION OF DIGITAL INTERFEROGRAM EVALUATION TECHNIQUES TO THE MEASUREMENT OF THREE-DIMENSIONAL FLOW FIELDS

F. BECKER and Y. H. YU (U.S. Army, Aeromechanics Laboratory, Moffett Field, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 16 p. refs (AIAA PAPER 85-0037)

A system for digitally evaluating interferograms, based on an image-processing system connected to a host computer, has been implemented. The system supports one- and two-dimensional interferogram evaluations. Interferograms are digitized, enhanced, and then segmented. The fringe coordinates are extracted, and the fringes are represented as polygonal data structures. Fringe numbering and fringe interpolation modules are implemented. The system supports editing and interactive features, as well as graphic visualization. An application of the system to the evaluation of double-exposure interferograms from the transonic flow field around a helicopter blade and the reconstruction of the three-dimensional flow field is given. Author

A85-20874#

EXPERIMENTAL AND THEORETICAL ANALYSIS OF LAMINAR SEPARATION BUBBLES

E. WEIBUST, A. BERTELUD, and S. O. RIDDER (Flygtekniska Forsoksanstalten, Bromma, Sweden) American Institute of Aeronautics and Astronautics, Applied Aerodynamics Conference, 2nd, Seattle, WA, Aug. 21-23, 1984. 12 p. Research sponsored by the Styrelsen for Teknisk Utveckling. refs (AIAA PAPER 84-2201)

Experimental and computational results from flow in and around laminar separation bubbles are given, with emphasis on the reattachment region. The experimental bubble parameters are correlated with existing formulae, utilizing a novel method of measuring with dense spacing in and behind the rear part of the

bubble. Removal of the separation bubble by means of a transition trip is discussed. Author

A85-20884

OFF-DESIGN POINT CHARACTERISTICS OF THE PRECOOLED GAS TURBINE CYCLE WITH LIQUEFIED HYDROGEN AS FUEL

Y. TSUJIKAWA and T. SAWADA (Osaka Prefecture University, Sakai, Japan) International Journal of Hydrogen Energy (ISSN 0360-3199), vol. 9, no. 12, 1984, p. 1011-1017. refs

The off-design point performance of a precooled gas turbine cycle fueled with liquid hydrogen is analyzed. The gas turbine equips the precooler and hydrogen turbine in order that the cryogenic exergy (available energy) can be effectively converted to useful work. The design point is determined by using an estimating function, F . The thermodynamic analysis reveals that even at the off-design point working conditions the thermal efficiency of this cycle is also relatively high compared to that of conventional gas turbine cycle and the load factor decreases in keeping with the decrease in the temperature of the working fluid at the inlet of the gas turbine. Author

A85-20915#

RADAR CROSS SECTION LECTURES

A. E. FUHS (U.S. Naval Postgraduate School, Monterey, CA) New York, American Institute of Aeronautics and Astronautics, 1984, 132 p. refs

A comprehensive account is given of the principles that can be applied in military aircraft configuration studies to minimize the radar cross section (RCS) that will be presented by the resulting design to advanced radars under various mission circumstances. It is noted that, while certain ECM techniques can be nullified by improved enemy electronics in a very short time, RCS reductions may require as much as a decade of radar development before prior levels of detectability can be reestablished by enemy defenses. Attention is given to RCS magnitude determinants, inverse scattering, the polarization and scattering matrix, the RCSs of flat plates and conducting cylinders, and antenna geometry and beam patterns. O.C.

A85-21278#

A THEORETICAL STUDY OF STABILITY OF A RIGID ROTOR UNDER THE INFLUENCE OF DILUTE VISCOELASTIC LUBRICANTS

A. MUKHERJEE (Indian Institute of Technology, Kharagpur, India), R. BHATTACHARYYA, and A. M. RAO DASARY ASME, Transactions, Journal of Tribology (ISSN 0742-4787), vol. 107, Jan. 1985, p. 75-81. refs
(ASME PAPER 84-TRIB-17)

The present investigation is concerned with the determination of stable boundaries of a symmetrical horizontal rigid rotor supported by two identical short bearings using dilute viscoelastic fluids as lubricants. It has been found that the use of viscoelastic lubricants improves the bearing performances at high shear rates. Harnoy (1976) proposed a constitutive equation with a view to separate the contributions of relaxation and normal stress effects. The results presented in the current investigation are essentially dependent on the stress relaxation effect and may be qualitatively valid for a large class of fluids. Harnoy's constitutive equation is adopted only as it rationally permits the deletion of the Weissenberg effect in short bearings still retaining the objectivity of the constitutive equation. An evaluation is conducted of the dynamic performance of a short bearing using viscoelastic lubricants in the light of Harnoy's ideas. G.R.

A85-21283#

EFFECTS OF TURBULENCE AND VISCOSITY VARIATION ON THE DYNAMIC COEFFICIENTS OF FLUID FILM JOURNAL BEARINGS

D. F. WILCOCK (Tribolock, Inc., Schenectady, NY) and O. PINKUS (Mechanical Technology, Inc., Latham, NY) American Society of Mechanical Engineers and American Society of Lubrication Engineers, Joint Lubrication Conference, San Diego, CA, Oct. 22-24, 1984. 6 p. refs
(ASME PAPER 84-TRIB-8)

Many high-speed or large fluid film bearings operate in the turbulent regime. However, relatively little consideration has been given to the effects of turbulence and of the variation in viscosity on the dynamic stiffness and damping characteristics of the bearings. Since the dynamic behavior of the rotor supported on such bearings is often closely tied to the bearing dynamic coefficients, knowledge of them may be critical to both the design and the in-place correction of rotor instabilities. These effects are here considered in some detail on the basis of computer calculated analytical results, both in general dimensionless terms and with regard to a specific numerical example. Author

A85-21293*# Texas A&M Univ., College Station.

ANALYSIS AND TESTING FOR ROTORDYNAMIC COEFFICIENTS OF TURBULENT ANNULAR SEALS WITH DIFFERENT, DIRECTIONALLY-HOMOGENEOUS SURFACE-ROUGHNESS TREATMENT FOR ROTOR AND STATOR ELEMENTS

D. W. CHILDS and C.-H. KIM (Texas A & M University, College Station, TX) American Society of Mechanical Engineers and American Society of Lubrication Engineers, Joint Lubrication Conference, San Diego, CA, Oct. 22-24, 1984. 10 p. refs
(Contract NAS8-33716)
(ASME PAPER 84-TRIB-31)

A combined analytical-computational method has been developed to calculate the transient pressure field and rotordynamic coefficients for high-pressure annular seals. The solution procedure applies to constant-clearance or the convergent tapered geometries of multistage centrifugal pumps which may have different surface roughness conditions on the stator and rotor seal elements. In experimental calculations with the method, the turbulent equations of Hirs (1973) are modified slightly to account for different surface roughness conditions, and a perturbation analysis is employed to develop zeroth and first order perturbation equations. Zeroth equations are also used to define both the leakage and circumferential flow due to shear stresses around the stator and rotor surfaces. The solution to analytical equations for four different surface roughnesses confirm the predicted net damping for the seals. A round-holed stator pattern yielded the highest net damping and lowest leakage of all the seals tested. I.H.

A85-21296#

STABILITY OF SQUEEZE FILM DAMPED MULTI-MASS FLEXIBLE ROTOR BEARING SYSTEMS

E. J. HAHN (New South Wales, University, Kensington, Australia) and L. J. MCLEAN American Society of Mechanical Engineers and American Society of Lubrication Engineers, Joint Lubrication Conference, San Diego, CA, Oct. 22-24, 1984. 8 p. refs
(ASME PAPER 84-TRIB-45)

A technique is presented for investigating the stability of and the degree of damping in the circular synchronous orbit equilibrium solutions pertaining to radially symmetric multi-mass flexible rotor bearing systems. It involves the analysis of appropriate linearized perturbation equations about the equilibrium solutions and is applicable to systems with several squeeze film dampers. For a system with a single damper, stability threshold maps, independent of unbalance distribution, may be found in terms of the same damper parameters and operating conditions as the equilibrium solutions, thereby allowing for damper design and performance monitoring. The technique is illustrated for a simple symmetric four degree of freedom flexible rotor with an unpressurized damper. This example shows the utility of zero frequency stability maps for delineating multiple solution possibilities

and that for low (in this case of the order of 0.06 or lower) bearing parameters, the introduction of an unpressurized squeeze film damper may promote instability in an otherwise stable system.

Author

A85-21385

ADVANCED-COMPOSITE JOINTS AND FITTINGS FOR PRIMARY STRUCTURAL COMPONENTS

H. S. SALUJA (Boeing Vertol Co., Philadelphia, PA) IN: Composite structures; Proceedings of the National Specialists' Meeting, Philadelphia, PA, March 23-25, 1983. Washington, DC, American Helicopter Society, 1984, 3 p.

This paper discusses advanced-composite bonded and bolted joints and their applications for primary structural components. Also discussed are a bolted primary structural joint design for a composite longeron and the longeron itself made of T300/5209 graphite/epoxy caps supported by honeycomb core. Tension, compression, pin bearing, and combined tension and bearing coupon tests were performed on the longeron cap. Two designs for the composite longeron splice fitting were considered: a hairpin fitting and a T-fitting. The joint tests were successful in meeting ultimate design loads of 44,700 and 42,300 pounds in tension and compression, respectively. A conclusion was drawn from the test results regarding the effect of bearing stresses on the ultimate strength of the joint.

Author

A85-21460#

PACKAGING AND INTERCONNECTION FOR AVIONICS

N. CHANDLER (General Electric Co., PLC, Research Laboratories, Chelmsford, Essex, England) IN: Design and advanced concepts of avionics/weapons system integration; Proceedings of the Symposium, London, England, April 3, 4, 1984. London, Royal Aeronautical Society, 1984, 7 p.

Following some examples of current equipment practice in avionics, future alternatives are discussed in terms of the various types of package and interconnection medium, particularly in relation to the increasing scale of integration on silicon. Assembly requirements are briefly addressed and a summary is given of trends in packaging and interconnection for avionics.

Author

A85-21683

THE DEVELOPMENT OF A FINITE ELEMENT MODEL OF AN AIRCRAFT VERTICAL STABILIZER FOR VIBRATION ANALYSIS

R. J. MCKINNELL (Council for Scientific and Industrial Research, National Institute for Aeronautics and Systems Technology, Pretoria, Republic of South Africa) Aeronautical Society of South Africa and South African Institute of Aeronautical Engineers, Journal (ISSN 0250-3786), vol. 5, no. 1, 1984, p. 52-55. refs

A finite element idealization of the vertical stabilizer of a light transport aircraft was generated and a linear dynamic analysis of the structure was carried out using the ASKA software package. The structure was modeled using primarily normal-stress flange elements and plane-stress membrane elements. Ground vibration testing of the stabilizer was also used to find natural frequencies and modal response at resonance. The first five modes of vibration of the structure were investigated. Comparison of calculated and measured modal frequencies and modeshapes showed that the model generated could be successfully used in dynamic analysis, although some refinement would be necessary to increase accuracy.

Author

A85-21846*# Purdue Univ., Lafayette, Ind.

VIBRATION TAILORING OF ADVANCED COMPOSITE LIFTING SURFACES

T. A. WEISSHAAR (Purdue University, West Lafayette, IN) and B. L. FOIST (Northrop Corp., Advanced Systems Div., Pico Rivera, CA) (Structures, Structural Dynamics and Materials Conference, 24th, Lake Tahoe, NV, May 2-4, 1983, Collection of Technical Papers. Part 2, p. 498-508) Journal of Aircraft (ISSN 0021-8669), vol. 22, Feb. 1985, p. 141-147. Navy-supported research. Previously cited in issue 12, p. 1744, Accession no. A83-29861. refs (Contract NAG1-157)

A85-21875*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

NONREFLECTING BOUNDARY CONDITIONS FOR THE COMPLETE UNSTEADY TRANSONIC SMALL-DISTURBANCE EQUATION

W. WHITLOW, JR. and D. A. SEIDEL (NASA, Langley Research Center, Loads and Aeroelasticity Div., Hampton, VA) AIAA Journal (ISSN 0001-1452), vol. 23, Feb. 1985, p. 315-317. refs

Nonreflecting far-field boundary conditions that are consistent with the complete transonic small-disturbance (TSD) equations are derived. They are implemented in a new code for solving the complete TSD equation and are tested for a harmonically oscillating NACA 64A010 airfoil in transonic flow and for a flat-plate airfoil with a pulse in the angle of attack. Using the new boundary conditions on a relatively small grid, solutions for the airfoil that are obtained that agree with large-grid calculations, resulting in a 44 percent savings in computer time. Frequency responses for the flat plate show that most of the disturbances incident on the computational boundaries are absorbed by the boundary conditions.

C.D.

A85-21985

AN OPTIMALITY CRITERION METHOD FOR STRUCTURES WITH STRESS, DISPLACEMENT AND FREQUENCY CONSTRAINTS

A. ZACHAROPOULOS, K. D. WILLMERT (Clarkson University, Potsdam, NY), and M. R. KHAN (Bechtel Corp., Power Div., San Francisco, CA) Computers and Structures (ISSN 0045-7949), vol. 19, no. 4, 1984, p. 621-629. refs

Presented in this paper is a procedure, based on optimality criterion methods, for the minimum weight design of structures subjected to stress, displacement and natural frequency constraints. The technique presented is a combination of a previously developed method for stress and displacement constraints alone and one for frequency limited structures. The method is applied to a delta-wing example, and the optimal designs obtained are compared to previously published results. The new method is capable of obtaining the optimal design in a small number of iterations, without significant calculations beyond a standard analysis. No approximate analyses or determination of large numbers of Lagrange multipliers are involved.

Author

A85-22105

OPTIMAL CONTROL OF FLOW OF A VISCOUS INCOMPRESSIBLE FLUID [OB OPTIMAL'NOM UPRAVLENII POTOKOM VIAZKOI NESZHIMAEMOI ZHIDKOSTI]

M. A. BRUTIAN and P. L. KRAPIVSKII Prikladnaia Matematika i Mekhanika (ISSN 0032-8235), vol. 48, Nov.-Dec. 1984, p. 929-934. In Russian. refs

Flow of a viscous incompressible fluid past an arbitrary body, with tangential or normal velocity being controlled on its surface, is analyzed using Navier-Stokes equations. The necessary conditions for minimum energy dissipation rate are derived. Exact analytical solutions for the corresponding problems in the case of flow past an ellipsoid are obtained using the Stokes approximation.

V.L.

A85-22113

CALCULATION OF THE HYDRODYNAMIC CHARACTERISTICS OF POLYPLANES [ROZRACHUNKOVIDNOSTI KAKHARAKTERISTIK POLIPLANIV, SHCHO KOLIVAIUT'SIA]

O. A. SHCHIPTSOV (Akademiia Nauk Ukrain's'koi RSR, Institut Gidromekhaniki, Kiev, Ukrainian SSR) Akademiia Nauk Ukrain's'koi RSR, Dopovidi, Serii A Fiziko-Matematichni ta Tekhnichni Nauki (ISSN 0002-3531), Nov. 1984, p. 46-48. In Ukrainian.

The problem of the oscillatory motion of a polyplane in an ideal incompressible fluid is solved in a linear formulation using the discrete vortex method. Results of numerical calculations are presented as plots of the coefficient of the longitudinal force component vs the dimensionless motion velocity. The results can be useful in evaluating the efficiency of various propulsion systems.

V.L.

A85-22114

CALCULATION OF FRICTION AND HEAT TRANSFER IN TURBULENT FLOW OF A COMPRESSIBLE GAS IN A PLANE DUCT [RASCHET TRENIIA I TEPLOOBMENA PRI TURBULENTNOM TECHENII SZHIMAEMOGO GAZA V PLOSKOM KANALE]

IU. I. SHVETS, I. E. VIROZUB, V. F. VISHNIAK, N. M. KONDAK, V. N. PANCHENKO, and G. A. FROLOV (Akademiiia Nauk Ukrainskoi SSR, Institut Tekhnicheskoi Teplofiziki, Kiev, Ukrainian SSR) *Inzhenerno-Fizicheskii Zhurnal* (ISSN 0021-0285), vol. 48, Jan. 1985, p. 19-23. In Russian. refs

Equations of turbulent flow of a compressible gas in a plane duct, with uniform velocity and temperature profiles at the inlet, are integrated numerically. It is assumed that the molecular viscosity coefficient is proportional to temperature, while the turbulent viscosity coefficient is determined on the basis of the Prandtl hypothesis with a damping multiplier. Calculations for the case of constant wall temperature during cooling are compared with experimental data. V.L.

A85-22168

EVALUATION OF THE FORWARD SCATTERING SPECTROMETER PROBE. I ELECTRONIC AND OPTICAL STUDIES

J. E. DYE and D. BAUMGARDNER (National Center for Atmospheric Research, Boulder, CO) *Journal of Atmospheric and Oceanic Technology* (ISSN 0739-0572), vol. 1, Dec. 1984, p. 329-344. refs

Laboratory studies of the Forward Scattering Spectrometer Probe (FSSP) were conducted to better understand the operation, to determine limitations and to define the measurement accuracy of the instrument for airborne cloud physics research. The studies included electronic checks of the instrument sensitivity to simulated particles of different sizes, airspeeds and arrival rates; measurement of important aspects of the optical configuration; and intercomparisons of six different FSSPs in a small wind tunnel with a droplet spray. The tests demonstrated measurement differences between various probes in several areas as well as areas in which there was reasonable agreement. Part of the differences can be attributed to different feature and design specifications of different probes as changes were made to improve the FSSP. Areas in which care needs to be taken in the calibration and processing of data from the FSSP are identified. Author

A85-22232#

UNIVERSAL MATRICES TO OBTAIN THERMAL LOAD VECTORS FOR THE FAMILY OF ANISOTROPIC PLANE TRIANGULAR FINITE ELEMENTS

C. RAMESH BABU and G. SUBRAMANIAN (Indian Institute of Technology, Madras, India) *Aeronautical Society of India, Journal* (ISSN 0001-9267), vol. 36, May 1984, p. 137-140.

Finite element techniques are applied to the thermal load analysis of aircraft and rocket structures subjected to kinetic heating conditions. Expressions are derived which define the universal matrices for anisotropic elements with temperatures prescribed at every node. Calculations are performed for E-glass/epoxy and carbon/epoxy plates with linear temperature variation from -50 to +50 C and the results are shown to agree well with previous isotropic calculations. Basic universal matrices for the CST, LST, and QST elements are given. The algorithm, easily adapted for computers, can be extended to three-dimensional tetrahedral elements. L.T.

A85-22240

CALCULATION OF THREE-DIMENSIONAL UNSTEADY INCOMPRESSIBLE FLOWS BY A VORTEX METHOD [CALCUL D'ECOULEMENTS TRIDIMENSIONNELS INSTATIONNAIRES INCOMPRESSIBLES PAR UNE METHODE PARTICULAIRE]

S. HUBERSON (CNRS, Laboratoire d'Informatique pour la Mecanique et les Sciences de l'Ingenieur, Orsay, Essonne, France) *Journal de Mecanique Theorique et Appliquee* (ISSN 0750-7240), vol. 3, no. 5, 1984, p. 805-819. In French. refs

A method derived from Rehbach's vortex method which permits the computation of three-dimensional flows of an incompressible fluid around an obstacle with arbitrary motion is presented. In Rehbach's method, the vortex field is discretized by means of turbulence particles. The flow is therefore described by two fields of discrete vectors: the vortex carried by each particle and a vector position characterizing the particle at each step of time. The method is applied to the flow around an oscillating flat plate placed in a uniform stream and is of interest in the study of the flow around complex configurations such as helicopter rotors, propellers, and wings with control surfaces. M.D.

A85-22281* Washington Univ., Seattle.

METALLURGICAL AND MECHANICAL PHENOMENA DUE TO RUBBING OF TITANIUM AGAINST SINTERED POWDER NICHROME

R. ZENAS, T. ARCHBOLD, J. WOLAK, A. F. EMERY, and S. ETEMAD (Washington, University, Seattle, WA) *ASLE Transactions*, vol. 28, Jan. 1985, p. 97-103. refs (Contract NAG3-7)

Metallurgical and mechanical changes occurring during high-speed rubbing of Ti-6Al-4V blade specimens against an abradable Nichrome aircraft engine seal material were studied using optical microscopy, electron microscopy, and microhardness techniques. Evidence of temperatures above the beta transus of Ti-6Al-4V (1000 C) and of thermal hardening was found on blade tips that exhibited undesirable abrading characteristics resulting in high forces of interaction, high temperatures, and smearing. The material within the layer of the corresponding seals was found to be work-hardened to a depth of about 0.1 mm and showed evidence of densification extending to a depth of about 0.5 mm below the rubbed surface. Wear particles produced by rub interactions that generated cleanly abraded seal surfaces were found to be several times larger than those produced during interactions which showed evidence of surface smearing and seal densification. Author

A85-22445#

A METHOD OF FORECASTING ACTIVE CONSTRAINT WITH THE APPLICATIONS TO STRUCTURAL OPTIMIZATION

Y. JIANG Chinese Society of Astronautics, *Journal*, no. 4, 1984, p. 44-54. In Chinese, with abstract in English. refs

A new approach to forecasting active constraint in an optimization problem is proposed. The constraints are chosen according to the projective direction, in which the objective function gradients project on the intersection of active constraints previously chosen. The number of active constraints is gradually increased until the cone, which is obtained by the gradient vector of these linearly independent constraints, can contain the objective function gradients. After establishing the explicit representation of the constraints, the method is applied to the DJY-2 structural optimization program similar to ACCESS 1. The high quality constraint linearization and the precision of constraint forecasting of this method allow almost identical active constraints to be obtained in several adjacent iterations. A space truss, a box wing, and a delta wing are calculated with satisfactory results. It is shown that this method considerably improves computational efficiency. C.D.

N85-15671# British Aerospace Aircraft Group, Stockport (England). Structures Dept.

ADVANCED FATIGUE MONITORING ON SERVICE AIRCRAFT
A. WALKDEN /In AGARD Operational Loads Data 16 p Aug. 1984 refs

Avail: NTIS HC A14/MF A01

An exercise on a Royal Air Force aircraft where typical service data was collected to: (1) define the loading actions which should be included in a full scale wing fatigue test; (2) enable theoretical fatigue lives for wing, tailplane, fin and undercarriage to be calculated; and (3) define which parameters might be measured in a comprehensive fit of advanced fatigue meters so that the life of the main structural components of each aircraft could be accurately measured is described. R.J.F.

N85-15672# British Aerospace Aircraft Group, Preston (England).

EXPERIENCES OBTAINED FROM SERVICE FATIGUE MONITORING EXERCISES

A. P. WARD /In AGARD Operational Loads Data 16 p Aug. 1984 refs

Avail: NTIS HC A14/MF A01

Two recent empennage fatigue load monitoring exercises involving the Jaguar and the Jet Provost aircraft are described. In each case digital recording technique were used and rainfall analysis techniques were employed to determine fatigue loading matrices. Problems were encountered in analysing the recorded data and these are enumerated. The more recent assessment of the Jet Provost provided a high rate of data recovery and benefited from experiences gained from the Jaguar exercise. The conventional method of assessing fin load spectra was found not to provide an adequate safeguard for the later Marks of Jet Provost where significant changes in operating patterns and speeds could not be taken into account adequately by theoretical methods. R.J.F.

N85-15680# British Aerospace Aircraft Group, Preston (England).

TORNADO: STRUCTURAL USAGE MONITORING SYSTEM (SUMS)

A. P. WARD /In AGARD Operational Loads Data 13 p Aug. 1984 refs

Avail: NTIS HC A14/MF A01

The background for the establishment of the tornado structural usage monitoring system (SUMS) is reviewed. The possible monitoring methods and the decision to opt for two approaches using flight parameters and load calibrated strain gauges are amplified. The calibration and instrumentation requirements are described and the use of SUMS data is discussed. E.A.K.

N85-15681# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).

KEEPING UP WITH OPERATIONAL LOADS IN THE FRENCH AIR FORCE: DEFINING NEW EQUIPMENT [SUIVI DES CHARGES EN SERVICE DANS L'ARMEE DE L'AIR FRANCAISE DEFINITION D'UN NOUVEAU MATERIEL]

L. BARANES and J. P. CORNAND /In its Operational Loads Data 12 p Aug. 1984 In FRENCH

Avail: NTIS HC A14/MF A01

To remedy the lacunae of present statistical accelerometers for following the operational loads of French Air Force aircraft a system was developed which offers the possibility of acquiring multiple parameters in association with a better data reduction logic. Topics covered include: (1) following real loads with emphasis on problems posed by using simple accelerometers; (2) defining the characteristics of the system developed and experience using the prototype; (3) a description of the series version of the prototype system for studying structural damage (SPEES); and (4) applications envisioned and future development considered for SPEES. Transl. by A.R.H.

N85-15682# Aeritalia S.p.A., Torino (Italy). Gruppo Velivoli da Combattimento.

FLIGHT PARAMETERS RECORDING FOR STRUCTURE FATIGUE LIFE MONITORING

F. STAROPOLI /In AGARD Operational Loads Data 7 p Aug. 1984 refs

Avail: NTIS HC A14/MF A01

The Tornado flight parameter recording system and its role in structure fatigue life monitoring are described. The system performs both on-board and on-ground recording and analysis functions. The fatigue analysis block program, data filtering subroutine, and damage calculation subroutine are described. The benefits of the system to fleet life management and safety are discussed. E.A.K.

N85-15683# Aeronautical Systems Div., Wright-Patterson AFB, Ohio. Force Management Group.

USAF APPROACH TO AIRBORNE STRUCTURAL DATA RECORDING: AIRBORNE DATA ACQUISITION MULTIFUNCTION SYSTEM (ADAMS)

R. J. VELDMAN /In AGARD Operational Loads Data 3 p Aug. 1984 refs

Avail: NTIS HC A14/MF A01

Current approaches to structural recording and considerations of future instrumentation systems are presented. The current state of the art of microprocessor technology lends itself to the development of airborne recording systems capable of onboard processing and data compression with solid state data storage. Such systems reduce supportability requirements because of increased reliability inherent to solid state electronics while providing processing and self diagnostic capability which were heretofore unachievable. These microprocessor based systems which record structural operational information are designated within the Air Force as the (ADAMS) airborne data acquisition multifunction system. E.A.K.

N85-15746# Brown Boveri Research Center, Baden (Switzerland).

EXPERIENCES WITH THE MATERIAL BEHAVIOUR AND HIGH TEMPERATURE LOW CYCLE FATIGUE LIFE PREDICTION OF THE IN 738 BLADING ALLOY

M. Y. NAZMY, H. WETTSTEIN, and A. WICKI (Brown, Boveri and Co. Ltd, Baden, Switzerland) /In AGARD Eng. Cyclic Durability by Analysis and Testing 12 p Sep. 1984 refs

Avail: NTIS HC A12/MF A01

The high temperature low cycle fatigue (HTLCF) behavior of the blading alloy IN 738 as studied in air at 850 C is studied. This aided in a basic understanding of the behavior of this alloy as well as the different methodologies used in life time prediction. Another part of the investigation was focused on the influence of different environmental effects on the (HTLCF) behavior. These environmental conditions were chosen to simulate as much as possible the actual conditions imposed on the gas turbine blades. Mainly sulfur containing environments were utilized for this purpose. Author

N85-15748# Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio. Turbine Engine Div.

VERIFICATION OF LIFE PREDICTION THROUGH COMPONENT TESTING

R. J. HILL /In AGARD Eng. Cyclic Durability by Analysis and Testing 9 p Sep. 1984

Avail: NTIS HC A12/MF A01

A status on report on the results of current rig and component testing being conducted under the life assessment testing (LAT) approach to turbine engine durability validation is given. Focus is the combination of using material of reduced life capability and creatin conditions of higher stress to produce short-time failure for cost effective validation of the tools and rules of life prediction. The three components discussed are combustors, compressor disks and turbine blades. B.W.

N85-15940 Department of the Air Force, Washington, D.C.
VOICE COMMAND WEAPONS LAUNCHING SYSTEM Patent
 H. E. BROWN, inventor (to Air Force) 14 Sep. 1984 7 p
 Supersedes AD-D009839

(AD-D011378; US-PATENT-4,471,683;
 US-PATENT-APPL-SN-411946; US-PATENT-CLASS-89-1A)
 Avail: US Patent and Trademark Office CSCL 17B

This abstract discloses a voice-controlled weapons launching system for use by a pilot of an aircraft against a plurality of simultaneously appearing (i.e., existing) targets, such as two or more aggressor aircraft (or tanks, or the like) attacking more aggressor aircraft. The system includes, in combination, a voice controlled input device linked to and controlling a computer; apparatus (such as a television camera, receiver, and display), linked to and actuated by the computer by a voice command from the pilot, for acquiring and displaying an image of the multi-target area; a laser, linked to and actuated by the computer by a voice command from the pilot to point to (and to lock on to) any one of the plurality of targets, with the laser emitting a beam toward the designated (i.e., selected) target; and a plurality of laser beam-rider missiles, with a different missile being launched toward and attacking each different designated target by riding the laser beam to that target. Unlike the prior art, the system allows the pilot to use his hands full-time to fly and to control the aircraft, while also permitting him to launch each different missile in rapid sequence by giving a two-word spoken command after he has visually selected each target of the plurality of targets, thereby making it possible for the pilot of a single defender aircraft to prevail against the plurality of simultaneously attacking aircraft, or tanks, or the like. GRA

N85-15941 Department of the Air Force, Washington, D.C.
EMI (ELECTROMAGNETIC INTERFERENCE) FILTER CAPACITOR UNIT Patent

G. W. MILLER and L. L. MCCLINTOCK, inventors (to Air Force)
 7 Aug. 1984 7 p Supersedes AD-D010558
 (AD-D011392; US-PATENT-4,464,702;
 US-PATENT-APPL-SN-504183; US-PATENT-CLASS-361-328)
 Avail: US Patent and Trademark Office CSCL 09E

The unit comprises several rolled capacitor elements in a single case, with a package concept that allows installation mounting and electrical interconnection on the same top plane. A U-shaped feedthrough bus in the form of a wide metal strip is routed from a top input terminal down the center of the case and up adjacent one wall to a top output terminal. The capacitor elements are in two sets on opposite sides of the center portion of the feedthrough bus, and connected thereto. A ground bus serving as an internal noise partition connected to the metal top is between the capacitor elements of one set and the outer portion of the feedthrough bus. A minimum of three units may be used with the variable speed constant frequency (VSCF) converter of the three-phase power supply system of an aircraft, for filtering and suppression of electromagnetic interference. The construction permits use of two input terminals bussed together, and two output terminals bussed together for handling large currents. Author (GRA)

N85-15949# Selenia S.p.A., Rome (Italy). Special System Design Dept.

EQUIPMENT FOR PREFLIGHT TEST OF AN ELECTRONIC COUNTERMEASURES (ECM) AVIONIC SYSTEM

V. BUONTEMPO In *its Rivista Tec.* Selenia, Vol. 9, No. 1 p 28-36 1984 refs
 Avail: NTIS HC A03/MF A01

Equipment used for the logistic support of the first level of maintenance of an ECM system is described. Design aspects such as mean time to repair and testability which give appreciable benefits to the readiness for the mission of the ECM system and the strike aircraft which carries it are outlined. Author (ESA)

N85-15954# Human Engineering Labs., Aberdeen Proving Ground, Md.

LITERATURE REVIEW OF VOICE RECOGNITION AND GENERATION TECHNOLOGY FOR ARMY HELICOPTER APPLICATIONS Final Report

K. A. CHRIST Aug. 1984 27 p
 (AD-A146878; HEL-TN-11-84) Avail: NTIS HC A03/MF A01
 CSCL 17B

This report is a literature review on the topics of voice recognition and generation. Areas covered are: manual versus vocal data input, vocabulary, stress and workload, noise, protective masks, feedback, and voice warning systems. Results of the studies presented in this report indicate that voice data entry has less of an impact on a pilot's flight performance, during low-level flying and other difficult missions, than manual data entry. However, the stress resulting from such missions may cause the pilot's voice to change, reducing the recognition accuracy of the system. The noise present in helicopter cockpits also causes the recognition accuracy to decrease. Noise-cancelling devices are being developed and improved upon to increase the recognition performance in noisy environments. Future research in the fields of voice recognition and generation should be conducted in the areas of stress and workload, vocabulary, and the types of voice generation best suited for the helicopter cockpit. Also, specific tasks should be studied to determine whether voice recognition and generation can be effectively applied. GRA

N85-15993*# Boeing Commercial Airplane Co., Seattle, Wash.
COST AND BENEFITS OPTIMIZATION MODEL FOR FAULT-TOLERANT AIRCRAFT ELECTRONIC SYSTEMS Final Report

Jan. 1983 298 p refs
 (Contract NAS1-16669)
 (NASA-CR-166043; NAS 1.26:166043) Avail: NTIS HC A13/MF A01 CSCL 09C

The factors involved in economic assessment of fault tolerant systems (FTS) and fault tolerant flight control systems (FTFCS) are discussed. Algorithms for optimization and economic analysis of FTFCS are documented. R.S.F.

N85-16008# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Systems and Logistics.

A BIRD STRIKE HANDBOOK FOR BASE-LEVEL MANAGERS M.S. Thesis

R. P. PAYSON and J. D. VANCE Sep. 1984 223 p
 (AD-A147928; AFIT/GLM/LSM/84S-52) Avail: NTIS HC A10/MF A01 CSCL 05A

To help develop more awareness about bird strikes and bird strike reduction techniques, this thesis compiled all relevant information through an extensive literature search, review of base-level documents, and personal interviews. The final product--A Bird Strike Handbook for Base-Level Managers--provides information on bird strike statistics, methods to reduce the strike hazards, and means to obtain additional assistance. The handbook is organized for use by six major base agencies: Maintenance, Civil Engineering, Operations, Air Field Management, Safety, and Air Traffic Control. An appendix follows at the end. GRA

N85-16065*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

LAMINAR HEAT-TRANSFER DISTRIBUTIONS ON BICONICS AT INCIDENCE IN HYPERSONIC-HYPERVELOCITY FLOWS

C. G. MILLER, III, J. R. MICOL, and P. A. GNOFFO Jan. 1984 145 p refs
 (NASA-TP-2213; L-15645; NAS 1.60:2213) Avail: NTIS HC A07/MF A01 CSCL 20D

Laminar heating distributions were measured at hypersonic-hypervelocity flow conditions on a 1.9-percent-scale model of an aeroassisted vehicle proposed for missions to a number of planets. This vehicle is a spherically blunted, 12.84/7deg biconic with the fore-cone axis bent upward 7 deg relative to the aft-cone axis to provide selftrim capability. Also tested was a straight biconic (i.e., without nose bend) with the same nose radius

and half-angles as the bent-nose biconic. These measurements were made in the Langley Expansion Tube at free-stream velocities from 4.5 to 6.9 km/sec and Mach numbers from 6.0 to 9.0 with helium, nitrogen, air, and carbon dioxide test gases. The range of calculated thermochemical equilibrium normal-shock density ratios for these four test gases was 4 to 19. Angles of attack, referenced to the aft-cone, varied from 0 to 20 deg. Heating distributions predicted with a parabolized Navier-Stokes (PNS) code were compared with measurement for helium and air test gases. Measured windward and leeward heating levels were generally underpredicted by the PNS code for both test gases, and agreement was poorer on the leeward side than on the windward side. Author

N85-16067# Spectron Development Labs., Inc., Costa Mesa, Calif.

AERO-OPTICS EXPERIMENTAL TECHNIQUES Final Technical Report

W. C. ROSE Kirtland AFB, N. Mex. AFWL Jul. 1984 45 p
Prepared in cooperation with Rose Engineering and Research Inc.

(Contract F29601-82-C-0013)

(AD-A146755; AFWL-TN-84-30) Avail: NTIS HC A03/MF A01 CSCL 20D

This report summarizes results of a study to determine the most appropriate aerodynamic experimental techniques for gathering data in aircraft boundary layer and shear layer turbulent flow, flow fields. It focuses on two primary techniques: hot-wire anemometry and five-hole pressure probes, and develops reduction equations for obtaining the desired aerodynamic parameters from raw data. It also presents comparison of hot-wire data using splitfilm probes and x-film probes collected during an airborne experiment. GRA

N85-16069# McDonnell-Douglas Corp., Long Beach, Calif.
SOME IMPORTANT PROBLEMS IN UNSTEADY BOUNDARY LAYERS INCLUDING SEPARATION. 2: UNSTEADY BOUNDARY LAYERS CLOSE TO THE STAGNATION REGION OF SLENDER BODIES Annual Report, 15 Mar. 1983 - 14 Mar. 1984

T. CEBECI, K. STEWARTSON, and S. M. SCHIMKE Jun. 1984 39 p

(Contract F49620-82-C-0055)

(AD-A146964; MDC-J3527; AFOSR-84-0861TR) Avail: NTIS HC A03/MF A01 CSCL 20D

The evolution of unsteady boundary layers on the plane of symmetry of a slender prolate spheroid in uniform motion at constant angle of attack after an impulsive start has been studied for the case of prescribed pressure distribution. Calculated results have been obtained for angles of attack ranging from 30 degrees to 50 degrees and show, for example, that the unsteady-state solutions approach the steady-state solutions rapidly on the windward and leeward sides for $\alpha < \alpha_{sub c}$ (approximately - 41 degrees). This is also so on the windward side for $\alpha > \alpha_{sub c}$. On the leeward side for $\alpha > \alpha_{sub c}$, however, the unsteady boundary layer is initially unseparated but develops a region of reversed flow with increasing time. Subsequently, the streamwise displacement thickness develops a pronounced peak which leads to a singularity of the type observed by van Dommelen and Shen on a circular cylinder started impulsively from rest. Author (GRA)

N85-16070# Scientific Research Associates, Inc., Glastonbury, Conn.

DEVELOPMENT OF A NAVIER-STOKES ROTOR AND STATOR ANALYSIS Annual Report, 21 Jun. 1983 - 30 Jun. 1984

S. J. SHAMROTH, H. MCDONALD, B. C. WEINBERG, and D. V. ROSCOE Jun. 1984 39 p

(Contract F49620-83-C-0119)

(AD-A146967; SRA-R84-910004-1; AFOSR-84-0858TR) Avail: NTIS HC A03/MF A01 CSCL 20D

An important problem in axial flow turbomachinery is that of flow through a turbine or compressor stage in which interaction occurs between the rotor and the stator. Although several

experimental efforts have focused upon this problem, relatively little analysis has been applied to this problem. The present effort applies a Navier-Stokes analysis to the rotor/stator problem. The effort consists of several tasks. These include assessment of an existing Navier-Stokes analysis for time-dependent flows, exploration of appropriate boundary conditions, development of an appropriate coordinate system and a demonstration calculation. The present annual report discusses the time-dependent assessment, exploration of boundary conditions and the coordinate system problem. GRA

N85-16073# Tennessee Univ. Space Inst., Tullahoma. Dept. of Aerospace and Mechanical Engineering.

CONTAMINATION AND DISTORTION OF STEADY FLOW FIELD INDUCED BY DISCRETE FREQUENCY IN AIRCRAFT GAS TURBINES Annual Report, 1 Jan. - 31 Dec. 1983

M. KUROSAKA 16 May 1984 20 p

(Contract AF-AFOSR-0049-83)

(AD-A147092; AFOSR-84-0909TR) Avail: NTIS HC A02/MF A01 CSCL 20D

This annual technical report covers the first year, Phase 1 activity of a research program initiated in January 1, 1983. The main objective of the present program is to investigate the influence of Reynolds stresses of organized origin induced by discrete frequency disturbances - in deforming and affecting the steady internal flow of aircraft engines. In particular, attention of the present research is focused upon the effect of orderly disturbances such as: (1) the vortex whistle upon the Ranque-Hilsch effects, and (2) Karman vortex street in causing temperature separation within the wake of bodies. GRA

N85-16074# Massachusetts Inst. of Tech., Cambridge. Gas Turbine and Plasma Dynamics Lab.

CURRENT PROBLEMS IN TURBOMACHINERY FLUID DYNAMICS Semiannual Report, 1 Nov. 1983 - 30 Apr. 1984

E. M. GREITZER, J. L. KERREBROCK, W. T. TOMPKINS, JR., J. E. MCCUNE, and A. H. EPSTEIN Jun. 1984 106 p

(Contract F49620-82-K-0002)

(AD-A147127; AFOSR-84-0859TR) Avail: NTIS HC A06/MF A01 CSCL 20D

A multi-investigator program on problems of current interest in turbomachinery fluid dynamics is being conducted at the MIT Gas Turbine and Plasma Dynamics Lab. Within the scope of this effort, four different tasks, encompassing both design and off-design problems, have been identified. These are: (1) Investigation of fan and compressor design point fluid dynamics (including formation of design procedures using current three-dimensional transonic codes and development of advanced measurement techniques for use in transonic fans); (2) Studies of basic mechanisms of compressor stability enhancement using compressor casing/hub treatment; (3) Fluid mechanics of inlet vortex flow distortions in gas turbine engines; and (4) Investigations of three-dimensional analytical and numerical computations of flows in highly loaded turbomachinery blading. GRA

N85-16087# McDonnell-Douglas Corp., Long Beach, Calif.

SOME IMPORTANT PROBLEMS IN UNSTEADY BOUNDARY LAYERS INCLUDING SEPARATION. 1: NATURE OF SINGULARITY ON OSCILLATING AIRFOILS Annual Report

T. CEBECI, A. A. KHATTAB, and S. M. SCHIMKE Apr. 1984 19 p

(Contract F49620-82-C-0055)

(AD-A147897; MDC-J2990; AFOSR-84-1066TR) Avail: NTIS HC A02/MF A01 CSCL 20D

Preliminary results are presented for the analysis of unsteady laminar boundary layers on oscillating airfoils. An examination of the evolution of the boundary layer near the nose of an oscillating airfoil has revealed that, when the reduced frequency is of the same order as in experiments on dynamic stall, the unsteady boundary layer ceases to behave in a smooth manner just downstream of separation and before one cycle is completed. As for the case of the impulsively started circular cylinder, the irregular behavior signals the onset of a singularity in the solution of the

boundary layer equations. Numerical results for the method are compared with the numerical results of van Dommelen and Shen for the impulsively started circular cylinder, the irregular behavior signals the onset of a singularity in the solution of the boundary layer equations. Numerical results for the method are compared with the numerical results of van Dommelen and Shen for the impulsively started circular cylinder. GRA

N85-16096* # National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

HIGH TEMPERATURE THERMOCOUPLE AND HEAT FLUX GAUGE USING A UNIQUE THIN FILM-HARDWARE HOT JUNCTURE

C. H. LIEBERT, R. HOLANDA, S. A. HIPPENSTEELE, and C. A. ANDRACCHIO Dec. 1984 29 p refs Proposed for presentation at 30th Intern. Gas Turbine Conf. and Exhibition, Houston, Tex., 17-21 Mar. 1985; sponsored by ASME (NASA-TM-86898; E-2365; NAS 1.15:86898) Avail: NTIS HC A03/MF A01 CSCL 14B

A special thin film-hardware material thermocouple (TC) and heat flux gauge concept for a reasonably high temperature and high flux flat plate heat transfer experiment was fabricated and tested to gauge temperatures of 911 K. This concept was developed for minimal disturbance of boundary layer temperature and flow over the plates and minimal disturbance of heat flux through the plates. Comparison of special heat flux gauge Stanton number output at steady-state conditions with benchmark literature data was good and agreement was within a calculated uncertainty of the measurement system. Also, good agreement of special TC and standard TC outputs was obtained and the results are encouraging. Oxidation of thin film thermoelements was a primary failure mode after about 5 of operation. Author

N85-16098* # ITT Aerospace/Optical Div., Fort Wayne, Ind. **STEREO ELECTRO-OPTICAL TRACKING SYSTEM (SETS) Final Report**

E. W. KOENIG et al. Sep. 1984 47 p (Contract NAS1-16883) (NASA-CR-172471; NAS 1.26:172471; REPT-61270-10) Avail: NTIS HC A03/MF A01 CSCL 14B

The SETS is a remote, non-contacting, high-accuracy tracking system for the measurement of deflection of models in the National Transonic Facility at Langley Research Center. The system consists of four electronically scanned image dissector trackers which locate the position of Light Emitting Diodes embedded in the wing or body of aircraft models. Target location data is recorded on magnetic tape for later 3-D processing. Up to 63 targets per model may be tracked at typical rates of 1280 targets per second and to precision of 0.02mm at the target under the cold (-193 C) environment of the NTF tunnel. Author

N85-16100* # National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

INTEGRATED EXHAUST GAS ANALYSIS SYSTEM FOR AIRCRAFT TURBINE ENGINE COMPONENT TESTING

R. L. SUMMERS and R. C. ANDERSON Jan. 1985 28 p refs (NASA-TP-2424; E-2302; NAS 1.60:2424) Avail: NTIS HC A03/MF A01 CSCL 14B

An integrated exhaust gas analysis system was designed and installed in the hot-section facility at the Lewis Research Center. The system is designed to operate either manually or automatically and also to be operated from a remote station. The system measures oxygen, water vapor, total hydrocarbons, carbon monoxide, carbon dioxide, and oxides of nitrogen. Two microprocessors control the system and the analyzers, collect data and process them into engineering units, and present the data to the facility computers and the system operator. Within the design of this system there are innovative concepts and procedures that are of general interest and application to other gas analysis tasks. Author

N85-16156 Department of the Air Force, Washington, D.C. **TURBULENCE MEASUREMENT INTERFEROMETER APPARATUS Patent**

J. M. GEARY, inventor (to Air Force) 14 Aug. 1984 6 p Supersedes AD-D009885 (AD-D011377; US-PATENT-4,465,372; US-PATENT-APPL-SN-422429; US-PATENT-CLASS-356-359) Avail: US Patent and Trademark Office CSCL 20E

Turbulence measurement interferometer apparatus includes a station having an entrance pupil and an aerodynamically stable boom connected to the station. The station houses an optical mirror arrangement defining an optical axis which extends through the entrance pupil. The boom has an end point spaced from the station but disposed on the optical axis. A laser generates a low power beam which is split into first and second portions. The first portion is guided to the boom end point and launched therefrom as a spherical wavefront through turbulence in front of the entrance pupil and toward the mirror arrangement, which in turn transforms it into an object collimated wavefront. The second portion of the beam is transformed into a second collimated reference wavefront which is combined with the first collimated wavefront and produces an interference pattern which is recorded on a medium, such as a photographic plate. The interference pattern provides information on the turbulence structure present at the entrance pupil of the station. GRA

N85-16180* # National Aeronautics and Space Administration, Washington, D. C.

CLEARANCE FLOW-GENERATED TRANSVERSE FORCES AT THE ROTORS OF THERMAL TURBOMACHINES Ph.D. Thesis - Technische Univ., 1975

K. URLICH Oct. 1983 181 p refs Transl. into ENGLISH of "Durch Spaltstroemungen Hervorgerufene Querkraefte an den Laufern Thermischer Turbomaschinen", Munich p 1-159 Original language document was announced in IAA as A76-43249 Transl. by Scientific Translation Service, Santa Barbara, Calif. (Contract NASW-3542) (NASA-TM-77292; NAS 1.15:77292) Avail: NTIS HC A09/MF A01 CSCL 13I

Self-excited rotor whirl represents a serious hazard in the operation of turbomachines. The reported investigation has, therefore, the objective to measure the lateral forces acting on the rotor and to determine the characteristic pressure distribution in the rotor clearance area. A description is presented of an approach for calculating the leakage flow in the case of an eccentric rotor position on the basis of empirical loss coefficients. The results are reported of an experimental investigation with a turbine stage, taking into account a variation of the clearance characteristics. The pressure data measured are consistent with the theoretical considerations. G.R. (IAA)

N85-16196* # Air Force Human Resources Lab., Brooks AFB, Tex.

NONDESTRUCTIVE INSPECTION: IMPROVED CAPABILITIES OF TECHNICIANS Final Report

R. H. SUMMERS Oct. 1984 21 p (AD-A147388; AFHRL-TP-83-63) Avail: NTIS HC A02/MF A01 CSCL 05I

This report covers two research and development (R&D) efforts relating to non-destructive inspection (NDI) in the Air Force. Recent surveys have found Air Force NDI capability to lack the precision and reliability necessary to ensure the structural integrity of aircraft. In one of these R&D efforts, specifications were developed for a trainer that would allow NDI technicians to learn and practice the ultrasonic NDI technique on the job. Functional specifications were developed first, based on technician-trainer interaction requirements, and then they were converted to engineering specifications for acquisition purposes. In the other R&D effort reported here, a study was made of relationships between personnel information on NDI technicians and their inspection abilities. The results from extensive eddy current and ultrasonic inspection tests were paired with data on experience, attitudes, and training. No significant relationships were found between NDI

abilities and selected personnel features. The specifications for the NDI trainer have potentially wide applicability throughout the military and civilian NDI communities. Results of the survey of personnel information, paired with NDI performance scores, holds interest for the personnel selection system. There is apparently little advantage to prior airframe or metals experience, and neither the volunteer nor the non-volunteer performs inspections with an edge in precision or reliability. The underlying conclusion seems to add weight to the premise that additional practice at the job site is the best approach to improving NDI capability. GRA

N85-16219# Fraunhofer-Inst. fuer Betriebsfestigkeit, Darmstadt (West Germany).

THE INFLUENCE OF FASTENER FLEXIBILITY ON LOAD TRANSFER AND FATIGUE LIFE PREDICTIONS FOR MULTIROW BOLTED AND RIVETED JOINTS

H. HUTH 1984 147 p refs In GERMAN; ENGLISH summary

(LBF-FB-172/84; ISSN-0721-5320) Avail: NTIS HC A07/MF A01 Karlsruhe, West Germany DM 90

A universal formula to calculate fastener flexibility was derived from load deformation measurements performed with a variety of commonly used types of single and double shear joints under quasi-static and flight-by-flight loading conditions. The improved accuracy of load transfer calculations is proved by comparative load transfer measurements with multirow joints. Load transfer mechanisms, especially under cyclic loading, are demonstrated, suggesting that fatigue life predictions based on local strains cannot be successful. A method for fatigue life estimation of multirow joints with shear-loaded fasteners is proposed. Author (ESA)

N85-16733# Naval Surface Weapons Center, Dahlgren, Va.

JOINT SERVICE DESIGN FOR TESTABILITY PROGRAM

W. L. KEINER In AGARD Design for Tactical Avionics Maintainability 5 p Oct. 1984 refs

Avail: NTIS HC A13/MF A01

As electronics become more complex and more critical to weapon system operation, there is an acknowledge that new designs must be somehow constrained to be more easily tested or they may become completely unsupportable. As a result, design for testability is becoming increasingly important to the services. The Joint Logistics Commanders (JLC) Panel on Automatic Testing established a comprehensive program to coordinate the development of testing technology and its management within the military services. One important part of the program deals with the design aspects of the prime equipment which permit weapon systems to be more easily and confidently tested using automatic test resources. A JLC Testability Subpanel was established under the JPLC Panel to provide acquisition support tools and research and development programs in design for testability (DFT).

Author

N85-16736# Ferranti Ltd., Edinburgh (Scotland). Product Support Dept.

A PRACTICAL EXAMPLE OF REDUCING LIFE CYCLE COSTS AND INCREASED AVAILABILITY

R. P. F. LAUDER In AGARD Design for Tactical Avionics Maintainability 11 p Oct. 1984 refs

Avail: NTIS HC A13/MF A01

The principles underlying effective operational availability are explored and quantified. It is shown that although large sums of money are expended on producing reliable components, these are vitiated if the end equipment is not exposed to a reliability growth program, because only 10% of the calculated mean time between failures (MTBF) will be realised in practice. It is claimed that costs can be reduced by using common commercial components without loss of MTBF provided it is followed by a reliability growth program. A practical example is given of the expensive and time consuming steps which have to be taken in resucing a low MTBF radar, and increasing its availability. The steps and the methodology leading to them are described and the results shown. M.G.

N85-16738# Dowty Electronics Ltd., London (England). Controls Div.

EXPERIENCE OF ONE UK ELECTRONIC EQUIPMENT SUPPLIER WITH BITE ON ENGINE/FLIGHT CONTROL SYSTEMS OVER THE PAST TEN YEARS

R. DEGAYE In AGARD Design for Tactical Avionics Maintainability 18 p Oct. 1984 refs

Avail: NTIS HC A13/MF A01

Early analogue electronic controllers for gas turbine control and A/C flight control applications were complex and poorly understood by A/C maintenance personnel - they were relatively easy to remove from their installation compared with the surrounding hydro-mechanical components. Both of these factors led to high unconfirmed defect rates, since these electronic black boxes were usually the first to be blamed for system problems. There was a clear need for some kind of built in fault identification system. The history of Dowty electronics involvement in BITE over the last ten years is traced. The techniques used, successes and failures, and customer reactions are described. A range of civil and military, analogue and digital applications are discussed and four civil applications described in detail. B.W.

N85-16765# Joint Publications Research Service, Arlington, Va. **DESIGNER ON AEROFLOT AUTOMATED COMMO SYSTEM DEVELOPMENT**

O. GONCHAROVA In its USSR Rept.: Transportation (JPRS-UTR-85-001) p 4-5 15 Jan. 1985 Transl. into ENGLISH from Vozdushnyy Transp. (Moscow), 17 Nov. 1984 p 3

Avail: NTIS HC A09/MF A01

Aeroflot digital communication collects and distributes data with a multilevel structure, each level of which is intended for preliminary processing of the data. On the first level, the airborne communications unit performs the initial collection and processing of flight performance information and transmits it to the ground communications center. On the second level, the data comes in from a group of aircraft accommodated by a given digital line. On the third level, the data coming in at the message switching center are processed and distributed among the civil aviation ground services. Capabilities of Aeroflot are compared with those of systems used in the United States and in Western European countries. A.R.H.

N85-16779# Naples Univ. (Italy).

TURBULENT BUBBLES BEHIND AIRFOILS AND WINGS AT HIGH ANGLE OF ATTACK

V. LOSITO and G. TORELLA In AGARD Improvement of Aerodynamic Performance Through Boundary Layer Control and High Lift Systems 13 p Aug. 1984 refs

Avail: NTIS HC A18/MF A01

More accurate inviscid and viscous flow models are needed for simulating the main features of the turbulent bubbles in the near wakes behind airfoils at high angles of attack. Descriptions of these flows are not sufficiently detailed to allow accurate modelling for the recirculating flow regions. Numerical and wind tunnel experiments are required to ensure convergence criteria and wake closure conditions at different Reynolds numbers. A simple relation was found which correlates the airfoils viscous lift loss with the location of the upper surface separation point and lift predicted in full attached flow conditions. This simple two-dimensional model was extended to three-dimensional wing flows with embedded turbulent bubbles after a set of wind tunnel experiments and oil-flow visualizations. A fast and efficient method is given for predicting spanwise load distribution and C sub L max for finite unswept wings. R.S.F.

**N85-16807# Elmer, Rome (Italy).
TACTICAL HF COMMUNICATION FOR MILITARY
HELICOPTERS USING THE NVIS MODE**

G. PUCETTI and P. L. COMO /n AGARD Helicopter Guidance and Control Systems for Battlefield Support 9 p Aug. 1984 refs

Avail: NTIS HC A13/MF A01

The use of loop antennas for tactical HF communications on board of military helicopters was investigated. The helo platform is considered for land or maritime scenarios. The experiments on the SH-3D helicopter compared the loop antennas and existing wire antennas. Groundwave radiated field at different azimuth angles were measured for the two antenna types, particularly at the lower end of the frequency range where the difference in the antenna geometry is more significant. A consistent better performance of the loop over the wire, typically a 16 dB to 8 dB improvement is indicated. Skywave propagation tests at different distances and altitude of the helicopter were conducted. It is found that the performance of the loop antenna is superior to the wire. It is concluded that the loop antenna is an ideal radiator for use onboard aircraft and helicopters because of its dimensions, increased efficiency, and radiation characteristics. E.A.K.

**N85-16810# AEG-Telefunken, Ulm (West Germany).
LPI-RADAR FOR HELICOPTER OBSTACLE WARNING**

H. MEINEL, H. G. WIPPICH, B. REMBOLD, and W. F. X. FRANK /n AGARD Helicopter Guidance and Control Systems for Battlefield Support 7 p Aug. 1984 refs

Avail: NTIS HC A13/MF A01

Employing the frequency range of maximum atmospheric attenuation around 60 GHz, a short range obstacle warning radar for helicopters was developed which can be operated under low probability of intercept conditions. Test flights with this noncoherent solid state radar showed that power cables as well as tall trees can be detected, even under adverse weather conditions. System considerations and test results are described. R.J.F.

**N85-17159 Rolls-Royce Ltd., London (England).
FLEXIBLE MANUFACTURING SYSTEM FOR THE PRODUCTION
OF AIRCRAFT PARTS**

M. WECK et al. 13 Nov. 1984 16 p refs Transl. into ENGLISH from Ind. Anzeiger (West Germany), v. 10, no. 32, 20 Apr. 1979 p 42-46

(BLL-PNR-90237-(899.3153)) Avail: British Library Lending Div., Boston Spa, Engl.

The flexible manufacturing system for the machining of integral aircraft components not only comprises control functions for numerical control machines and material flow in the data management and distribution system but also includes a complex processing system for organization data. Especially important is the automatic data feedback from the production line, the prompt availability of data to the associated sectors of the firm contributing towards shorter planning and decision times. The deliberate creation of sub-systems which operate independently, and the material flow control and monitoring system for interlinked machines, also provides the condition which allows them to be used on their own in similar fields of application or as stages in a gradual expansion of a manufacturing system. B.G.

N85-17162# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Systems and Logistics.

**THE EFFECTS OF MANUFACTURING AUTOMATION ON THE
SURGE AND MOBILIZATION CAPABILITIES OF THE GAS
TURBINE ENGINE INDUSTRY M.S. Thesis**

F. E. DRESSEL and V. F. GAUL Sep. 1984 101 p
(AD-A147295; AD-E500683; AFIT/GSM/LSY/84S-9) Avail:
NTIS HC A06/MF A01 CSCL 05A

This thesis determines the effects of manufacturing automation on the surge and mobilization capabilities of the gas turbine engine industry. Five specific manufacturing characteristics are investigated: labor, flexibility, manufacturing inputs, equipment utilization, and lead time. The combined information showed mostly positive effects on surge and mobilization. Some areas showed

no effect due to automation and the only negative effect was in one aspect of mobilization. Both companies reported an increased reliance on foreign suppliers for equipment and machinery, which would hamper their ability to expand their facilities during mobilization. Positive effects are anticipated for both surge and mobilization through increased flexibility, reduced labor requirements, and reduced manufacturing inputs requirements. Finally, the positive effects on these characteristics combined, are expected to significantly reduce the lead time required to deliver engine components and thereby for the engines themselves.

GRA

**N85-17193# Joint Publications Research Service, Arlington, Va.
FRG CERAMIC ENGINE COMPONENTS (PET) Abstract Only
In its West Europe Rept.: Sci. and Technol. (JPRS-WST-85-001)
p 6 2 Jan. 1985 Transl. into ENGLISH from Frankfurter
Zeitung/Blick Durch die Wirtsch. (Frankfurt/Main), 1 Nov. 1984 p
7**

Avail: NTIS HC A05/MF A01

Ceramic engine components for spark ignition and diesel engines for the development of ceramic rotors and ceramic-lined turbocharger housing are discussed. Ceramic port liners for thermal insulation of the exhaust gas channel in the cylinder head are cast into the cylinder head using improved manufacturing methods. Less heat would be given off by the cooling system, the exhaust temperatures would rise, hydrocarbon emissions would drop by 10% and catalytic treatment of the exhaust gases would be more favorable. The lining of the exhaust manifolds was investigated. It is difficult to manufacture the necessary shape while simultaneously adhering to close manufacturing tolerances. The ceramic lining of the combustion chamber still needs more development. Designs which lend themselves to ceramic linings, and the selection of suitable ceramic materials are emphasized. The objective of the development of ceramic engines is the reduction of fuel consumption by nearly 8% which is made possible by higher operating temperatures. Engine heat losses, however, must be minimized, and it is found that ceramics are suitable for this task. E.A.K.

**N85-17294*# Sunstrand Energy Systems, Rockford, Ill.
DESIGN AND TEST OF A FOUR CHANNEL MOTOR FOR
ELECTROMECHANICAL FLIGHT CONTROL ACTUATION Final
Report**

Dec. 1984 245 p

(Contract NAS9-16535)

(NASA-CR-171838; NAS 1.26:171838; S8308-R1) Avail: NTIS
HC A11/MF A01 CSCL 09A

To provide a suitable electromagnet torque summing approach to flight control system redundancy, a four channel motor capable of sustaining full performance after any two credible failures was designed, fabricated, and tested. The design consists of a single samarium cobalt permanent magnet rotor with four separate three phase windings arrayed in individual stator quadrants around the periphery. Trade studies established the sensitivities of weight and performance to such parameters as design speed, winding pattern, number of poles, magnet configuration, and strength. The motor electromagnetically sums the torque of the individual channels on a single rotor and eliminate complex mechanical gearing arrangements. A.R.H.

N85-17298# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Systems and Logistics.

**LIFE CYCLE COST MODEL FOR VERY HIGH SPEED
INTEGRATED CIRCUITS M.S. Thesis**

E. A. LONG Sep. 1984 242 p
(AD-A147798; AFIT/GLM/LSM/84S-39) Avail: NTIS HC
A11/MF A01 CSCL 14A

The Very High Speed Integrated Circuit (VHSIC) technology program is forecast to have a profound impact on performance, reliability, and cost of future avionics systems. An important question is: how do VHSIC design fabrication and support concepts impact life cycle cost (LCC) of a host system? To answer this question, an insertion model representative of future avionics

systems is selected and LCCs are obtained for various chip designs and layout configurations which implement this model. This thesis then examines five factors affecting VHSIC chips with respect to LCC of a digital synthetic aperture radar processor. These factors are: (1) chip technology and design; (2) fabrication yields; (3) substrate type; (4) the degree to which computer-aided-design (CAD) methods are used; and (5) maintenance level. Of these factors, the greatest impact to LCC is chip fabrication yields. The least effect on LCC is the degree to which CAD methods are used. The remaining factors fall between these two. Originator-supplied keywords include: semiconductors, microcircuits and Chips(Electronics). GRA

N85-17351 Illinois Univ., Urbana-Champaign.
THEORETICAL AND EXPERIMENTAL ANALYSES OF LASER ALTIMETERS FOR BAROMETRIC MEASUREMENTS OVER THE OCEAN Ph.D. Thesis

B. M. B. TSI 1984 214 p

Avail: Univ. Microfilms Order No. DA8422167

The optical path length from a satellite to the Earth's surface is strongly dependent on the atmospheric pressure along the propagation path. Surface pressure can be determined by measuring the difference between the round-trip propagation times of laser pulses that are transmitted simultaneously at two wavelengths. Although pressure measurements can be made over the ground and water, the application of this technique to pressure measurements over the ocean is considered. The statistical characteristics and the waveforms of the ocean reflected laser pulses are studied. The statistics of time-resolved speckle and its effects on the timing accuracy of the receiver are studied in the general context of laser altimetry. The data obtained from the first airborne two-color laser altimeter experiment are processed and analyzed. The results are used to verify the pressure measurement concept. Dissert. Abstr.

N85-17353*# Old Dominion Univ., Norfolk, Va. Dept. of Physics.

NASA THREE-LASER AIRBORNE DIFFERENTIAL ABSORPTION LIDAR SYSTEM ELECTRONICS Final Report, 15 Dec. 1979 - 31 Dec. 1984

R. J. ALLEN and G. D. COPELAND Dec. 1984 85 p refs (Contract NCC1-32)

(NASA-CR-174293; NAS 1.26:174293; PTR-84-3) Avail: NTIS HC A05/MF A01 CSCL 20E

The system control and signal conditioning electronics of the NASA three laser airborne differential absorption lidar (DIAL) system are described. The multipurpose DIAL system was developed for the remote measurement of gas and aerosol profiles in the troposphere and lower stratosphere. A brief description and photographs of the majority of electronics units developed under this contract are presented. The precision control system; which includes a master control unit, three combined NASA laser control interface/quantel control units, and three noise pulse discriminator/pockels cell pulser units; is described in detail. The need and design considerations for precision timing and control are discussed. Calibration procedures are included. R.S.F.

N85-17363*# National Aeronautics and Space Administration, Washington, D. C.

TURBO FLUID MACHINERY AND DIFFUSERS

T. SAKURAI Sep. 1984 220 p Transl. into ENGLISH of the book "Kikkan Kogyo Shinbunsha" Japan, 30 Sep. 1983 187 p Transl. by Scientific Translation Service, Santa Barbara, Calif. (Contract NASW-4004)

(NASA-TM-77467; NAS 1.15:77467) Avail: NTIS HC A10/MF A01 CSCL 13I

The general theory behind turbo devices and diffusers is explained. Problems and the state of research on basic equations of flow and experimental and measuring methods are discussed. Conventional centrifugation-type compressor and fan diffusers are considered in detail. R.S.F.

N85-17369# Department of the Air Force, Washington, D.C.

FLOW MEASUREMENT DEVICE Patent Application

T. C. CHANDLER, inventor (to Air Force) 17 Oct. 1984 18 p (AD-D011432; US-PATENT-APPL-SN-661834) Avail: NTIS HC A02/MF A01 CSCL 13G

A device is described for measuring fuel flow to a power plant such as a turbo fan engine with a very high degree of accuracy, for example, + or - 0.5%. A tubular flow loop having quick disconnect fittings for detachably connecting the loop between the aircraft fuel system outlet and the engine fuel inlet is disclosed. Two specially calibrated mass flow transmitters are arranged in series, each preceded by a straight section of piping having a preferred given length to diameter ratio. Preceding each of the two straight pipe sections is a honeycomb flow straightener and three in-series perforated plates for removing any effects of upstream flow characteristics from the transmitters. GRA

N85-17398# National Aerospace Lab., Amsterdam (Netherlands). Structures and Materials Div.

ENGINEERING PROPERTY COMPARISONS OF PM AND IM ALUMINUM ALLOY FORGINGS

R. J. H. WANHILL and L. SCHRA 23 Nov. 1983 23 p refs Presented at ASTM Symp. on Rapidly Solidified Powder Aluminum Alloys, Philadelphia, Apr. 1984

(AD-B0881466L; NLR-MP-83066-U) Avail: NTIS HC A02/MF A01

Strength, fracture toughness, fatigue strength, fatigue crack propagation resistance under constant amplitude and spectrum loading, stress corrosion crack initiation and propagation resistance, and exfoliation corrosion of the PM alloy 7091-T7E69 and the IM alloys 7075-T73, 7175-T736, 7010-T736 and 7050-T736 were compared. The PM alloy has a substantially better combination of strength and resistance to stress corrosion and exfoliation and higher notched fatigue strength at low mean stress levels and long lives. However, the fracture toughness is lower than (L-T orientation) or similar to (T-L orientation) that of the IM alloys, and the resistance to fatigue crack propagation under spectrum loading is greatly inferior. There are only minor differences in properties between the IM alloys. Author (ESA)

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GEOSCIENCES

Includes geosciences (general); earth resources; energy production and conversion; environment pollution; geophysics; meteorology and climatology; and oceanography.

A85-19458*# Dayton Univ., Ohio.

CLEAR TURBULENCE FORECASTING - TOWARDS A UNION OF ART AND SCIENCE

J. L. KELLER (Dayton, University, Dayton, OH) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 8 p. NASA-NOAA-supported research. refs

(AIAA PAPER 85-0014)

The development of clear air turbulence (CAT) forecasting over the last several decades is reviewed in the context of empirical and theoretical research into the nature of nonconvective turbulence in the free atmosphere, particularly at jet stream levels. Various qualitative CAT forecasting techniques are examined, and prospects for an effective quantitative index to aid aviation meteorologists in jet stream level turbulence monitoring and forecasting are examined. Finally, the use of on-board sensors for short-term warning is discussed. V.L.

A85-19514#

RADAR FOR STORM FORECASTING AND WEATHER HAZARD WARNING

R. J. DOVIK and J. T. LEE (NOAA, National Severe Storms Laboratory, Norman, OK) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 7 p. Sponsorship: U.S. Department of Transportation. refs

(Contract DOT-FA01-80-Y-10524)

(AIAA PAPER 85-0092)

The capabilities, probable applications and shortcomings of Doppler radar are discussed. A nationwide network of Doppler radars (NEXRAD) is planned for the late 1980s to replace the current incoherent WSR-57 weather radars. The NEXRAD system will detect mesoscale events from which aircraft hazards such as tornadoes can originate. The system will also identify hail, excessive water, wind shear and turbulence in proportion to their fields of reflectivity factor, which is estimated from echo power levels, range and radar calibration constants. The enhanced accuracy of the Doppler equipment will lend credibility to aircraft severe weather warnings and encourage pilots to stay the recommended 20 km from thunderstorms. Lead times up to 23 min have been achieved for hail forecasts, especially with dual polarization radars. It is noted that sidelobe levels are a critical factor for Doppler radar angular resolution, and range and velocity errors are inversely proportional to each other. Better resolution can be obtained with phased arrays, SAR or larger antennas. M.S.K.

A85-21141

ICING CONDITIONS ENCOUNTERED BY A RESEARCH AIRCRAFT

W. R. SAND, W. A. COOPER, M. K. POLITOVICH, and D. L. VEAL (Wyoming University, Laramie, WY) Journal of Climate and Applied Meteorology (ISSN 0733-3021), vol. 23, Oct. 1984, p. 1427-1440. NSF-NOAA-supported research; U.S. Bureau of Reclamation and U.S. Department of Transportation. refs (Contract USBR-7-07-83-V0001; DOT-FA03-81-C-00020)

The characteristics of clouds which have led to airframe icing on an instrumented Beechcraft Super King Air are summarized. The icing encounters occurred at altitudes from 0-8000 m MSL, in summer and winter, in stratiform and cumuliform clouds, and at temperatures from 0 to -30 C. The characteristics of icing encounters in different areas and in different seasons are compared. The fraction of measurements exceeding various threshold values of liquid water content, average liquid water content over a given distance, volume-median droplet diameter, droplet concentration, ice crystal concentration, and potential ice accumulation are given. The effects of these cloud characteristics on aircraft performance were measured by comparing the rate of climb of the aircraft with ice to the rate of climb for the clean aircraft under the same conditions. Most icing encounters led to a reduction in the rate of climb that increased linearly with the path integral of the supercooled liquid water content. The volume-median diameter had little correlation with changes in performance. Some potentially hazardous conditions, which decreased the rate of climb capability of this aircraft by 7-9 m/s, are also discussed. Author

A85-21843*# Arizona Univ., Tucson.

IDENTIFICATION OF VORTEX-INDUCED CLEAR AIR TURBULENCE USING AIRLINE FLIGHT RECORDS

E. K. PARKS (Arizona University, Tucson, AZ), R. C. WINGROVE, R. E. BACH, and R. S. MEHTA (NASA, Ames Research Center, Moffett Field, CA) Journal of Aircraft (ISSN 0021-8669), vol. 22, Feb. 1985, p. 124-129. Previously cited in issue 06, p. 798. Accession no. A84-17989. refs

N85-17435# Argonne National Lab., Ill. Air Resources Section. IMPACT OF AIRCRAFT EMISSIONS ON AIR QUALITY IN THE VICINITY OF AIRPORTS. VOLUME 3: AIR QUALITY AND EMISSION MODELING NEEDS Final Report

D. M. ROTE Jan. 1984 122 p Sponsored in part by AF 4 Vol.

(Contract DTFA01-83-4-10556)

(AD-A147951; FAA/EE-84-13; AFESC/ESL-TR-84-35) Avail:

NTIS HC A06/MF A01 CSCL 09B

The first part of this report addresses the status of the AVAP (Airport Vicinity Air Pollution) model and AQAM (Air Quality Assessment Model) from the perspective of the modeling requirements of users concerned with air-quality problems in civilian and military aviation. Brief descriptions of the types of problems likely to be encountered is followed by a detailed discussion of those characteristics of the problems that determine the technical requirements for the applicable computation procedures or models. This is followed by a discussion of the operational or user requirements of the models. Then a review and evaluation of the AVAP model and AQAM is given that includes a discussion of their intended uses, strengths, and weaknesses. The methods used by the two models to treat various aspects of the emission and dispersion are compared, and the best methods are selected, or alternatives are recommended where appropriate. The latter portion of the report addresses the future needs. Because of the number of interrelated problems and decisions required to meet these needs, a systematic approach to the problem in the form of a decision tree is presented. The final section contains an outline of a proposed new computational system that should alleviate at least some of the problems identified in earlier sections. Two objections were paramount in the new design: to make the model easier to use and to be able to implement the model on modern, small computers. GRA

N85-17436# Argonne National Lab., Ill. Energy and Environmental Systems Div.

IMPACT OF AIRCRAFT EMISSIONS ON AIR QUALITY IN THE VICINITY OF AIRPORTS. VOLUME 4. NITROGEN DIOXIDE AND HYDROCARBONS Final Report, Jul. 1980 - Apr. 1984

K. L. BRUBAKER, M. DAVE, R. J. WINGENDER, and R. D. FLOTARD Apr. 1984 158 p

(Contract DTFA01-83-Y-10556)

(AD-A148253; FAA/EE-84-14; AFESC/ESL-TR-84-36) Avail:

NTIS HC A08/MF A01 CSCL 13B

This report documents the results of three related studies conducted to assess the impact of aircraft emissions of nitrogen oxides (NOx) and hydrocarbons (Hc) on air quality. The first study consisted of a field program carried out at O'Hare International Airport and an associated model development program, the purposes of which were to assess the effect of aircraft NOx emissions on ambient 1-hour concentrations of nitrogen dioxide (NO2) and to provide a dispersion model suitable for the prediction of such concentrations. The second study involved the collection and laboratory analysis of samples of hydrocarbons in ambient air contaminated by jet aircraft exhaust, together with a determination of the type and relative amounts of the various hydrocarbons detected. The third study consisted of an analysis, based on available data in the literature, of the potential role of aircraft hydrocarbon emissions in the production of photochemical smog. The available literature dealing with the issue of aircraft contributions to photochemical smog has been reviewed and is discussed. At present, the available information is insufficient to evaluate the effect quantitatively. The requirements for further work that would enable a quantitative evaluation to be made are discussed. GRA

13 GEOSCIENCES

N85-17470# California Univ., Riverside: Statewide Air Pollution Research Center.

ATMOSPHERIC PHOTOCHEMICAL MODELING OF TURBINE ENGINE FUELS. PHASE 1: EXPERIMENTAL STUDIES. VOLUME 2: ENVIRONMENTAL CHAMBER DATA TABULATIONS Final Report, Jun. 1983 - Jun. 1984

W. P. L. CARTER, A. M. WINER, R. ATKINSON, M. C. DODD, and W. D. LONG Sep. 1984 576 p

(Contract F08635-80-C-0359)

(AD-A147786; AFESC/ESL-TR-84-32-VOL-2) Avail: NTIS HC A25/MF A01 CSCL 04A

This report documents the results of the first phase of a two-phase program aimed at developing for the U.S. Air Force experimentally tested computer models to predict worst-case potentials for air quality degradation resulting from use of current and potential future turbine engine (jet) fuels. The development and testing of such models requires an adequate data base derived from appropriate environmental chamber experiments and laboratory studies. In Phase I of this two-phase program, a total of 131 environmental chamber experiments were carried out in a approx. 640000-liter, all Teflon indoor environmental chamber and several kinetic measurements were made in order to obtain data required for model development. The chamber experiments included 47 single component-NO_x-air irradiations of various representative fuel constituents and potential future fuel impurities, 15 fuel-NO_x-air irradiations of various representative fuel constituents and potential future fuel impurities, 15 fuel-NO_x-air irradiations employing one whole and six synthetic surrogate fuels, and 69 control or characterization runs. Volume II contains a tabulation of the environmental chamber data gathered during the course of the experimental phase of this program. GRA

N85-17492# Naval Postgraduate School, Monterey, Calif. **THE VISIBILITY CLIMATOLOGY OF MCMURDO SOUND-WILLIAMS FIELD, ANTARCTICA M.S. Thesis**

C. G. SOUDERS Mar. 1984 151 p

(AD-A148108) Avail: NTIS HC A08/MF A01 CSCL 04B

Accurate forecasting of visibility at McMurdo/Williams Field, Antarctica is essential for the air operations involving the resupply of United States bases and the conduct of research on the Antarctic continent. McMurdo, located at 77 deg 51' S 155 deg 40' E, receives all supplies destined for use by the United States Antarctic Research Program scientists. The Williams Field skiway and the adjacent ice runway are approximately 4.5 mi southeast of McMurdo. Weather observations are taken at both McMurdo and the operational airfield. The visibility climatology, August through March, for McMurdo (1956-1983) and Williams Field skiway/runway (1968-1983) was prepared using four operational visibility categories, as well as the seven important weather parameters which reduce visibility, namely, blowing snow, light snow, moderate to heavy snow, the three types of fog and ice crystals. A wind speed/direction climatology was also prepared because of its relation to both blowing snow and fog. GRA

N85-17494# New Mexico Inst. of Mining and Technology, Socorro.

A STUDY OF THE EFFECTS OF TRIGGERED LIGHTNING Final Report, 15 May 1982 - 31 Dec. 1983

C. B. MOORE and C. R. HOLMES Oct. 1984 40 p

(Contract AF-AFOSR-0206-82)

(AD-A148296; AFOSR-84-1024TR) Avail: NTIS HC A03/MF A01 CSCL 04A

The characteristics of lightning, artificially induced by wire-trailing rockets were measured in a cooperative program involving investigators from France, from the Flight Hazards Branch of Wright-Patterson Air Force Base and from New Mexico Institute of Mining & Technology. Lightning currents ranging from a few hundred amperes to a peak of 79 kA were measured. The waveforms of the electromagnetic signals produced by the lightning had associated magnetic field variations in excess of 10 T/s with rise times ranging from 40 ns to 1 microsecond. The development of an 11 cm radar was completed for a determination of the interaction between lightning and the surrounding atmosphere.

Preliminary data on lightning echoes have now been obtained with it. GRA

N85-17506# Department of the Navy, Washington, D. C.

A METHOD FOR DETERMINING MESOSCALE DYNAMIC TOPOGRAPHY Patent Application

J. L. MITCHELL, inventor (to Navy) 22 Feb. 1984 13 p

(AD-D011412; US-PATENT-APPL-SN-582412) Avail: NTIS HC A02/MF A01 CSCL 08J

A method for determining mesoscale dynamic topography places a satellite altimeter into a properly selected, exact repeating orbit. The proper mesoscale sampling strategy depends upon the nature of the frequency/wavenumber response of the mesoscale ocean which is different in different regions of the global ocean. The result is altimetry data completely free of geoid contamination and having an order of magnitude alleviation of the problem of temporal undersampling. Author (GRA)

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MATHEMATICAL AND COMPUTER SCIENCES

Includes mathematical and computer sciences (general); computer operations and hardware; computer programming and software; computer systems; cybernetics; numerical analysis; statistics and probability; systems analysis; and theoretical mathematics.

A85-19586#

A GENERALIZED STABILITY CRITERION FOR NONLINEAR DYNAMIC SYSTEMS

M. N. WAGDI (Suez (Anal University, Port Said, Egypt) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 6 p. refs (AIAA PAPER 85-0202)

A novel method is introduced that results in a generalized nonlinear stability criterion. The present approach is completely different from those of Malkin's (1959) and Lyapunov's (1950). The basic concept of the present methodology is to discretize the given nonlinear continuous system via the fourth order Runge-Kutta scheme. Sensitivity analysis is performed and state disturbance propagation is obtained through defined matrices. A stability matrix is then derived which is the sum of a first order matrix and a second order matrix. The stability criterion reduces to that of determining the eigenvalues of the stability matrix. A general nonlinear autonomous system will be stable if all the eigenvalues of the stability matrix are confined within a unit central circle in the complex plane. The stability characteristics of a model aircraft performing a nonlinear rapid roll maneuver is investigated by the present method. Author

A85-19782*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

NONITERATIVE THREE-DIMENSIONAL GRID GENERATION USING PARABOLIC PARTIAL DIFFERENTIAL EQUATIONS

T. A. EDWARDS (NASA, Ames Research Center, Moffett Field, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 9 p. refs

(AIAA PAPER 85-0485)

A new algorithm for generating three-dimensional grids has been developed and implemented which numerically solves a parabolic partial differential equation (PDE). The solution procedure marches outward in two coordinate directions, and requires inversion of a scalar tridiagonal system in the third. Source terms have been introduced to control the spacing and angle of grid lines near the grid boundaries, and to control the outer boundary point distribution. The method has been found to generate grids about 100 times faster than comparable grids generated via solution of elliptic PDEs, and produces smooth grids for finite-difference flow calculations. Author

A85-19835

A THREE-DIMENSIONAL KALMAN FILTER FOR SHORT OBSERVATION TIMES TO EXTRAPOLATE FLIGHT TRAJECTORIES [EIN DREIDIMENSIONALES KALMANFILTER FUER KURZE BEOBACHTUNGSZEITEN ZUR EXTRAPOLATION VON FLUGBAHNEN]

D. URMANN Hamburg, Hochschule der Bundeswehr, Fachbereich Maschinenbau, Dr.-Ing. Dissertation, 1984, 130 p. In German. refs

The application of Kalman filters of the type described by Singer (1970) to the computer-guided radar tracking of aircraft is investigated analytically. A system model of the generalized Kalman filter is introduced; the equations for the three-dimensional filter are derived; problems are identified; and technical or mathematical approaches to their solution are developed. It is found that correcting for the coupling of the Cartesian coordinates gives only minimal improvements in accuracy at significant computation costs, whereas the use of velocity measurements (from appropriate sensors) improves performance and solves the initialization problem at all but very low target velocities. Best overall results are achieved using an initialization procedure based on linear least-squares fitting. T.K.

A85-20856#

DESIGN OF AERODYNAMIC BODIES USING ARTIFICIAL INTELLIGENCE/EXPERT SYSTEM TECHNIQUE

S. S. TONG (General Electric Co., Schenectady, NY) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 7 p. refs (AIAA PAPER 85-0112)

This paper introduces the concept of coupling artificial intelligence/expert system and computational fluid dynamics techniques for the design of aerodynamic bodies. A general design system architecture is presented with illustrations of the programming methodology. Applications, limitations, and software requirements are discussed. A simple axial cooling fan design is used to demonstrate that such a design system can solve problems as well as human experts, reduce labor costs by eliminating user intervention during design iterations, and has the potential of out-performing the experts by systematically examining many more cases than a human being is capable of examining. Author

A85-21457

SOFTWARE DESIGN METHODS

W. J. CULLYER (Royal Signals and Radar Establishment, Malvern, Worcs., England) IN: Design and advanced concepts of avionics/weapons system integration; Proceedings of the Symposium, London, England, April 3, 4, 1984. London, Royal Aeronautical Society, 1984, 10 p. refs

Contemporary civil and military aircraft avionics systems comprise a large number of different, interconnected computers for air data gathering, inertial navigation, automatic flight direction, flight management and stores management; the assembly of such systems involves both mutual understanding as to design methods, and agreement on avionics interface standards, among companies located throughout Western Europe and North America. Attention is presently given to the CORE and MENTOR methods for automated assessment and integration of complex avionics requirements, as well as to the difficulties anticipated in conversion to the Ada high level programming language for military avionics. O.C.

A85-21458#

A DESIGN METHODOLOGY FOR INTEGRATED AVIONIC SYSTEMS

A. O. WARD (British Aerospace, PLC, Warton Div., Preston, Lancs., England) IN: Design and advanced concepts of avionics/weapons system integration; Proceedings of the Symposium, London, England, April 3, 4, 1984. London, Royal Aeronautical Society, 1984, 9 p. Research supported by the Royal Aircraft Establishment.

The increasing use of computers and the growing sophistication of sensors and displays has led to a rapid expansion in the

gathering, processing, and dissemination of information within airborne systems. The philosophy for the design of such systems has, moreover, been transformed from one of considering individual units to a comprehensive concern with information transfer and control architectures. Attention is presently given to the Controlled Requirements Expression (CORE) methodology, which consists of 11 logical steps for the generation of requirement decomposition according to system viewpoints, and their subsequent reconciliation. CORE has to date been applied to several small avionics-related projects in Britain. O.C.

A85-21548* College of William and Mary, Williamsburg, Va.

OPTIMAL MAINTENANCE CENTER INVENTORIES FOR FAULT-TOLERANT REPAIRABLE SYSTEMS

S. H. LAWRENCE and M. K. SCHAEFER (College of William and Mary, Williamsburg, VA) Journal of Operations Management (ISSN 0272-6963), vol. 4, Feb. 1984, p. 175-181. Research supported by the College of William and Mary. refs (Contract NSG-1625)

A probabilistic approach is taken to determine the optimal repairable parts inventory for a maintenance center, servicing machines which contain several m-out-of-n systems of different parts, with a constraint on the total inventory investment. A model, based on the discrete Markov process, accounts for a typical ultrareliable avionics system, such as one presently being developed by NASA. The dynamic programming algorithm for minimizing the stockout and holding costs is applied to an exemplary maintenance center, and solutions for single-item and multi-item cases are given. The computational burden is noted to be reasonable and a computer program is used to generate optimal solutions. L.T.

A85-21791*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

A LARGE-SCALE COMPUTER FACILITY FOR COMPUTATIONAL AERODYNAMICS

F. R. BAILEY and W. F. BALLHAUS, JR. (NASA, Ames Research Center, Moffett Field, CA) (Oak Ridge National Laboratory, NASA, NBS, et al., Nuclear Science Symposium, 31st, Orlando, FL, Oct. 31-Nov. 2, 1984) IEEE Transactions on Nuclear Science (ISSN 0018-9499), vol. NS-32, Feb. 1985, p. 202-208.

As a result of advances related to the combination of computer system technology and numerical modeling, computational aerodynamics has emerged as an essential element in aerospace vehicle design methodology. NASA has, therefore, initiated the Numerical Aerodynamic Simulation (NAS) Program with the objective to provide a basis for further advances in the modeling of aerodynamic flowfields. The Program is concerned with the development of a leading-edge, large-scale computer facility. This facility is to be made available to Government agencies, industry, and universities as a necessary element in ensuring continuing leadership in computational aerodynamics and related disciplines. Attention is given to the requirements for computational aerodynamics, the principal specific goals of the NAS Program, the high-speed processor subsystem, the workstation subsystem, the support processing subsystem, the graphics subsystem, the mass storage subsystem, the long-haul communication subsystem, the high-speed data-network subsystem, and software. G.R.

A85-21973* Stanford Univ., Calif.

WRITING EXECUTABLE ASSERTIONS TO TEST FLIGHT SOFTWARE

A. MAHMOOD, D. M. ANDREWS, and E. J. MCCLUSKEY (Stanford University, Stanford, CA) Annual Asilomar Conference on Circuits, Systems, and Computers, 18th, Pacific Grove, CA, Nov. 5-7, 1984, Paper. 6 p. refs (Contract NAG2-246) (SU-CRC-TR-84-14; CSL-TN-84-256)

An executable assertion is a logical statement about the variables or a block of code. If there is no error during execution, the assertion statement results in a true value. Executable assertions can be used for dynamic testing of software. They can be employed for validation during the design phase, and exception

and error detection during the operation phase. The present investigation is concerned with the problem of writing executable assertions, taking into account the use of assertions for testing flight software. They can be employed for validation during the design phase, and for exception handling and error detection during the operation phase. The digital flight control system and the flight control software are discussed. The considered system provides autopilot and flight director modes of operation for automatic and manual control of the aircraft during all phases of flight. Attention is given to techniques for writing and using assertions to test flight software, an experimental setup to test flight software, and language features to support efficient use of assertions. G.R.

A85-22274

ONERA - THE AERONAUTICS SUPERCOMPUTER IS PUT INTO SERVICE [ONERA - L'AERONAUTIQUE MET EN SERVICE SON SUPERCALCULATEUR]

R. NAZARETIAN *Air et Cosmos* (ISSN 0044-6971), vol. 22, Jan. 12, 1985, p. 27-29. In French.

The CRAY-1 S-2000 computer system recently installed by ONERA to meet the needs (increased by a factor of 60 over the last 10 years) of its own researchers and of its industrial contractors is characterized and illustrated with block diagrams and photographs. The factors evaluated in choosing the CRAY system over one based on the Cyber 205 are reviewed; the need for an aeronautics computer system to supplement ONERA's share in a CRAY system used by a number of French institutes is explained; and possible approaches to further expand ONERA computer capacity (since the present system has been used at nearly 100 percent of capacity since its activation) are considered. T.K.

A85-22374

THE USE OF LOCAL FUNCTIONALS TO CONSTRUCT A CIRCUMVENTION MANEUVER IN GAME PROBLEMS OF EVASION [PRIMENENIE LOKAL'NYKH FUNKSIONALOV DLIA POSTROENIIA MANEVRA OBKHODA V IGROVYKH ZADACHAKH UKLONENIIA OT PEREKHVATA]

N. A. ZABOLONOVA *IN: Ill-posed problems in perturbation theory* (A85-22364 08-02). Novosibirsk, Izdatel'stvo Nauka, 1984, p. 238-243. In Russian. refs

A85-22449#

THE DEVELOPMENT OF DIGITAL ATTITUDE CONTROLLERS - ITS PAST, PRESENT AND FUTURE

Y. SHAN *Chinese Society of Astronautics, Journal*, no. 4, 1984, p. 90-97. In Chinese, with abstract in English. refs

The development of digital attitude controllers is analyzed, and the necessity for the transition from the linear to the nonlinear domains is shown. Using nonlinear methods, it is possible not only to shape the amplitude and phase characteristics of the controllers, but also successfully to achieve a new index of controllable performance. The key problems which remain to be solved in the future development of nonlinear controllers are indicated. C.D.

N85-16503# Bolt, Beranek, and Newman, Inc., Canoga Park, Calif.

NOISEMAP 4.4 COMPUTER PROGRAM UPDATE, OPERATOR'S MANUAL, ADDENDUM 1 Final Report

R. D. HORONJEFF *Wright-Patterson AFB, Ohio AMRL* Sep. 1984 16 p

(Contract F33615-82-C-0501)

(AD-A147091; BBN-5657; AFAMRL-TR-78-109-ADD-1) Avail: NTIS HC A02/MF A01 CSCI 09B

This report, an addendum to a previous document, describes new capabilities for the NOISEMAP program that allow calculation of the daily noise exposure at 20 user-specified locations. The program also produces a detailed listing of the aircraft flight and ground operations which are the greatest contributors to the daily noise exposure at each specified location. NOISEMAP is a general purpose digital computer program which creates noise exposure maps for land areas surrounding civil and military air installations. The programs have been written in FORTRAN IV and optimized

for execution on Control Data Corporation (CDC) 6000, 7000, and Cyber 170 series computers. GRA

N85-16746# Pacific Missile Test Center, Point Mugu, Calif. Electronic Warfare Computer Resources Div.

EFFECTIVE LIFE CYCLE SOFTWARE SUPPORT: A STUDY IN DISCIPLINE AND VERSATILITY

G. H. SMITH *In AGARD Design for Tactical Avionics Maintainability* 7 p Oct. 1984

Avail: NTIS HC A13/MF A01

An effective life cycle software support capability that has evolved from emphasis being placed on a disciplined management process and a versatile set of laboratory facilities is characterized. The evolution of the capability described is still in progress. Much is yet to be accomplished in several areas. It is still very difficult to gain information in the early stages of the development cycle of a software system. Information that would enhance supportability and reduce eventual software support costs is elusive. Many of the configuration and data management functions are far too labor intensive. Great strides are possible in the automation and integration of data and documentation. As system complexities are certain to continually increase, so will the challenge to improve the approach to maintainability of the new generations of software. B.G.

N85-16747# Messerschmitt-Boelkow-Blom G.m.b.H., Munich (West Germany).

EXPERIENCE IN USING ON-AIRCRAFT SOFTWARE FOR TESTING INTEGRATED SYSTEMS

K. NUMBERGER *In AGARD Design for Tactical Avionics Maintainability* 20 p Oct. 1984 refs

Avail: NTIS HC A13/MF A01

A need exists for test software capable of monitoring complex avionic systems during flight and delivering the collected information immediately after the mission for debriefing and maintenance, and testing complex avionic system with respect to correct functioning and integration status. It is very important that during the test run easy switching between the operational program without reloading is possible. The following feature of the co-resident program have proved the most useful input data display, in-flight monitor, and extended individual equipment/system tests. The highest priority is therefore given to optimizing the co-resident software, especially the Advanced Ground Test Facility (AGTR), while the priority for the External Ground Test Program (EGTP) refinement was downgraded. B.G.

N85-16749# International Business Machines Corp., Research Triangle Park, N.C.

INVESTIGATING VERSION DEPENDENCE IN FAULT-TOLERANT SOFTWARE

R. K. SCOTT, J. W. GAULT (ARO, Research Triangle Park, N.C.), D. F. MCALLISTER (North Carolina State Univ., Raleigh), and J. WIGGS (North Carolina State Univ., Raleigh) *In AGARD Design for Tactical Avionics Maintainability* 11 p Oct. 1984 refs

Avail: NTIS HC A13/MF A01

The results are reported of an experiment conducted to validate the ability of several fault tolerant software reliability models to accurately predict system reliability. It was demonstrated that the dependent form of the model for the recovery block could predict reliability. The independent model failed to predict reliability due to version dependence. This dependence appeared to be due to the difficulty factor and not due to algorithmic dependence as might be expected. The recovery block does provide reliability gain over a single version of a program. It was demonstrated that the consensus recovery block approach to software fault tolerance was superior to the N version programming approach. R.S.F.

N85-16750# Dowty Electronics Ltd., London (England). Controls Div.

THE EFFECT ON SOFTWARE DESIGN OF TESTING BY SYMBOLIC EXECUTION

D. A. RUTHERFORD and F. LAM /in AGARD Design for Tactical Avionics Maintainability 5 p Oct. 1984

Avail: NTIS HC A13/MF A01

Some special characteristics of real time software are addressed. The cost impact on applying symbolic execution is discussed. The results obtained in a symbolic test are more comprehensive as the conditions that lead to a particular path being executed are recorded as well as the final contents of variables. A symbolic value can represent a class of numeric values. This offers the advantages of time saving in test data preparation. In the extreme, test specifications can be eliminated completely which means that the maintenance cost for the associated text document is eliminated also. An unquantifiable advantage is that symbolic execution gives the programmer more insight into the working of the module under test and thus helps to check the specification of the routine. The test captures the philosophies behind both black and white box testing. R.S.F.

N85-16751# LABEN Space Instrumentation and Systems, Milan (Italy).

RELIABLE SOFTWARE DESIGN FOR AVIONICS AND SPACE APPLICATIONS

P. DONZELLI and G. GIANNINI /in AGARD Design for Tactical Avionics Maintainability 11 p Oct. 1984 refs

Avail: NTIS HC A13/MF A01

The fundamental quality requirements of space software are the reliability and testability of software products. Only a structured methodology of software design can satisfy these peculiarities producing software modules with low coupling and high strength. The production of software with these features becomes more complex when the work environment of software is a real time one. The first step toward the creation of reliable software is the introduction of a structured software design methodology properly devoted to real time applications. The software design methodology developed by LABEN to produce software for real time systems for space applications is discussed. R.S.F.

N85-17194# Joint Publications Research Service, Arlington, Va. **DESCRIPTION OF MBB COMPUTERIZED DESIGN TECHNIQUES FOR A320**

/in its West Europe Rept.: Sci. and Technol. (JPRS-WST-85-001) p 7-9 2 Jan. 1985 Transl. into ENGLISH from VDI Nachr. (Dusseldorf), 28 Sep. 1984 p 26

Avail: NTIS HC A05/MF A01

The design of aircrafts by computerized design techniques is discussed. Picture screen, light marker, and computers are now exclusively the means by which the new Airbus A320 aircraft is built. Complete major structural parts, components, metal and synthetic material structures, down to the smallest sheet metal parts and connection elements are drawn on the picture screen, the drawing data are stored in computers, they are preserved on magnetic tape for use as construction documents, and they are reproduced on microfilm or they are printed out on paper. E.A.K.

N85-17578# Boeing Aerospace Co., Seattle, Wash. Engineering Technology Div.

SOFTWARE TEST HANDBOOK: SOFTWARE TEST GUIDEBOOK, VOLUME 2 Final Report, Mar. 1982 - Sep. 1983

E. PRESSON Griffiss AFB, N.Y. RADC Mar. 1984 281 p

(Contract F30602-82-C-0059)

(AD-A147289; RADC-TR-84-53-VOL-2) Avail: NTIS HC A13/MF A01 CSCL 09B

The purpose of the Software Test Handbook effort was to provide Air Force software developers with guidelines and methodology for the effective use of higher order language (HOL) software testing techniques and for the selection of automated tools for the testing of computer programs. The effort resulted in a two volume final technical report. Volume 1, the Final Technical Report, describes the total contractual effort. This report, Volume

2 - Software Test Guidebook, contains the guidelines and methodology resulting from the effort. In addition, it contains the following: (1) summary descriptions of the testing techniques, (2) an extensive bibliography, (3) typical paragraphs that can be included in software development Statements of Work (SOW) to specify the use of advanced software testing techniques by the contractor during the testing and verification phases of a contracted software development, and (4) a cross-reference to government and commercially available catalogs listing automated test tools that support the various testing techniques. Author (GRA)

N85-17603*# Massachusetts Inst. of Tech., Cambridge. Lab. for Information and Decision Systems.

RESEARCH ON OPTIMAL CONTROL, STABILIZATION AND COMPUTATIONAL ALGORITHMS FOR AEROSPACE APPLICATIONS Final Report, 1966 - 1984

M. ATHANS Oct. 1984 64 p refs

(Contract NGL-22-009-124)

(NASA-CR-174318; NAS 1.26:174318; LIDS-FR-1418;

MIT-OSP-76265) Avail: NTIS HC A04/MF A01 CSCL 09B

The research carried out in the areas of optimal control and estimation theory and its applications under this grant is reviewed. A listing of the 257 publications that document the research results is presented. R.S.F.

N85-17613# Technion - Israel Inst. of Tech., Haifa. Faculty of Industrial and Management Engineering.

TAIL BEHAVIOUR FOR SUPREMA OF EMPIRICAL PROCESSES Technical Report

R. J. ADLER and L. D. BROWN Sep. 1984 54 p

(Contract AF-AFOSR-0068-83)

(AD-A147629; AFOSR-84-0937TR) Avail: NTIS HC A04/MF A01 CSCL 12A

This document considers multi-variate empirical processes with an empirical distribution function based on i.i.d. variables with certain distribution functions. GRA

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PHYSICS

Includes physics (general); acoustics; atomic and molecular physics; nuclear and high-energy physics; optics; plasma physics; solid-state physics; and thermodynamics and statistical physics.

A85-19269#

NOISE OF AN AIRFOIL IN A FLOW [BRUIT D'UN PROFIL DANS UN ECOULEMENT]

P. GARCIA and P. GERARD (ONERA, Chatillon-sous-Bagneux, Hauts-de-Seine, France) (Colloque d'Acoustique Aeronautique, 9th, Compiiegne, France, Nov. 14-16, 1984) ONERA, TP, no. 1984-155, 1984, 26 p. In French. refs

(ONERA, TP NO. 1984-155)

The results of measurements of the noise emitted from the trailing edge of a NACA 0012 airfoil embedded in a turbulent flow in an anechoic wind tunnel are reported. Pressure taps were set in the wall and on the extrados and intrados of the airfoils, which was kept at a 0.4 deg angle of attack. The sensors near the trailing edge were calibrated to relate pressure fluctuation data to acoustic resonance. A grid of 47 electrostatic polarized plastic membranes on the chord allowed determination of the acoustic profile. A theoretical model was devised to interpret the data and characterize the turbulence scales. The associated acoustic field was calculated according to a theory by Howe (1977), which depended on describing the boundary layer, a problem solved by spectral wavenumber and fluctuating pressure and pressure spectra and turbulence scale techniques. M.S.K.

A85-19505#**AN EXPERIMENTAL STUDY OF SOUND ATTENUATION CHARACTERISTICS IN CIRCULAR DUCTS WITH LINED RADIAL BAFFLES**

M. A. SHARAF (Dynatech R/D Co., Cambridge, MA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 8 p. refs (AIAA PAPER 85-0079)

Experimental data are reported to show that the insertion of acoustically treated radial baffles in circular ducts can attenuate airborne noise in the ducts. The tests covered five different liner materials with different thicknesses, including fiberglass and foam, compressed to 0.5 in. A sound driver sent pulses down lined ducts and data were taken on spectra, frequencies, and amplitudes before and after the liners, which were placed at varying angles to each other. High acoustic resistance (HAR) liners produced broad spectral attenuation, while low acoustic resistance (LAR) liners resulted in spectral peaks at several frequencies. Increasing the angles between the liners had no effect on the attenuation in the case of HAR liners, but broadened the effectiveness of the LAR liners. Further studies are indicated on the effects of air flow in the duct and of point-reacting liners. M.S.K.

A85-19507*# Dynamics Technology, Inc., Torrance, Calif. INVESTIGATION OF NONLINEAR EFFECTS IN THE INSTABILITIES AND NOISE RADIATION OF SUPERSONIC JETS

S. I. JANJUA and D. K. MCLAUGHLIN (Dynamics Technology, Inc., Torrance, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 10 p. refs (Contract NAS1-17093) (AIAA PAPER 85-0081)

The nonlinear interactions of fluctuating components which produce noise in supersonic jet flows were studied experimentally. Attention was given to spectral components interactions and the spectral effects of increasing Re. A jet exhausted in perfectly expanded conditions was monitored by microphones in the maximum noise emission direction. Trials were run at Mach 1.4 and 2.1 and the Re was varied from 5000-20,000 and 9000-25,000, respectively. Hot-wire data were gathered to examine the mode-mode interactions and a point glow discharge was used to excite the jets. The noise was found to exhibit discrete frequency components and a single tone instability at Re below 10,000. Mode interactions were found to weaken after the instabilities reached a crescendo and then decayed, leading to a nonlinear spectral broadening effect. M.S.K.

A85-19729#**RADIATIVE ENTROPY PRODUCTION**

V. S. ARPACI (Michigan, University, Ann Arbor, MI) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985. 5 p. refs (AIAA PAPER 85-0408)

A radiative tensor is defined in terms of the specular moments of the radiative transfer equation and used to quantify radiative entropy production. The radiative stress is expressed in a manner similar to viscous stress as derived from elastic stress. Entropy production is considered in terms of radiation stress, conduction and friction effects in order to obtain its spatial distribution. A production minima is found to yield the least irreversible operating conditions when the production formula is applied to the case of aerodynamic heating. M.S.K.

A85-20236#**A LINEARLY CORRECTING METHOD OF DEVIATION FUNCTION FOR CONSIDERING THE INFLUENCE OF PRESSURE ON THE THERMODYNAMIC PROPERTIES OF COMBUSTION GAS**

J. YAN, Y. YANG, and M. LIU (Harbin Institute of Science and Technology, Harbin, People's Republic of China) Journal of Engineering Thermophysics, vol. 5, May 1984, p. 111-118. In Chinese, with abstract in English. refs

A85-20650#**THE UNAMBIGUOUS IN-FLIGHT DETERMINATION OF PROPELLER ROTATIONAL NOISE IN AIRCRAFT WITH FOUR-CYCLE COMBUSTION ENGINES [DIE EINDEUTIGE ERMITTLUNG DES PROPELLERDREHKLINGS BEI FLUGZEUGEN MIT 4-TAKT-VERBRENNUNGSMOTOREN IM FLUG]**

M. KALLERGIS (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Institut fuer Entwurfs-Aerodynamik, Brunswick, West Germany) Deutsche Arbeitsgemeinschaft fuer Akustik, Meeting, Darmstadt, West Germany, Mar. 27-29, 1984, Paper. 4 p. In German.

A technique permitting the separation of motor noise from propeller rotation noise in light aircraft with four-cycle engines when the number of cylinders is a multiple of the number of propeller blades is demonstrated. Six condenser microphones are mounted on the leading edge of the wing of a Cessna T-207 equipped with a three-blade controllable-pitch propeller and a six-cylinder engine with output 212 kW at 2600 rpm, and an additional microphone is placed 20 cm from the exhaust outlet; the signals from all seven microphones are recorded simultaneously on a multiband magnetic tape and analyzed. A two-channel FFT analyzer is used to perform in-phase subtraction in time domain of the motor exhaust signal from the mixed signal recorded at each wing microphone (after appropriate amplitude correction). A similar FFT technique in frequency domain is also shown. T.K.

A85-21842*# Bionetics Corp., Hampton, Va.**FIELD-INCIDENCE NOISE TRANSMISSION LOSS OF GENERAL AVIATION AIRCRAFT DOUBLE-WALL CONFIGURATIONS**

F. W. GROSVELD (Bionetics Corp., Hampton, VA) Journal of Aircraft (ISSN 0021-8669), vol. 22, Feb. 1985, p. 117-123. Previously cited in issue 06, p. 837, Accession no. A84-18133. refs (Contract NAS1-16978)

A85-21858*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.**SCALING OF AIRFOIL SELF-NOISE USING MEASURED FLOW PARAMETERS**

T. F. BROOKS and M. A. MARCOLINI (NASA, Langley Research Center, Acoustics and Noise Reduction Div., Hampton, VA) AIAA Journal (ISSN 0001-1452), vol. 23, Feb. 1985, p. 207-213. refs

Data from an airfoil broadband self-noise study are reported. Attention here is restricted to two-dimensional models at zero angle of attack to the flow. The models include seven NACA 0012 airfoil sections and five flat plate sections with chordlengths ranging from 2.54 to 60.96 cm. Testing parameters include flow velocity to 71.3 m/s and boundary-layer turbulence through natural transition and by tripping. Detailed aerodynamic measurements are conducted in the near-wake of the sharp trailing edges. The noise spectra of the self-noise sources are determined by the use of a cross-spectral technique. The acoustic data are normalized using the measured aerodynamic parameters in order to evaluate a commonly used scaling law. An examination of the Reynolds number dependence of the normalized overall levels has revealed a useful scaling result. This result appears to quantify the transition between turbulent boundary-layer trailing-edge noise and laminar boundary-layer vortex shedding noise. Author

A85-22071**A PATH MODEL OF AIRCRAFT NOISE ANNOYANCE**

S. M. TAYLOR (McMaster University, Hamilton, Ontario, Canada) Journal of Sound and Vibration (ISSN 0022-460X), vol. 96, Sept. 22, 1984, p. 243-260. refs

This paper describes the development and testing of a path model of aircraft noise annoyance by using noise and social survey data collected in the vicinity of Toronto International Airport. Path analysis is used to estimate the direct and indirect effects of seventeen independent variables on individual annoyance. The results show that the strongest direct effects are for speech interference, attitudes toward aircraft operations, sleep interruption and personal sensitivity to noise. The strongest indirect effects

are for aircraft Leq(24) and sensitivity. Overall the model explains 41 percent of the variation in the annoyance reported by the 673 survey respondents. The findings both support and extend existing statements in the literature on the antecedents of annoyance.

Author

N85-16586*# Old Dominion Univ., Norfolk, Va. Dept. of Electrical Engineering.

ULTRASOUND INSTRUMENTATION FOR THE 7 INCH MACH SEVEN TUNNEL Final Report, 28 Aug. - 31 Dec. 1984

D. S. MAZEL and R. R. MIELKE Jan. 1985 29 p refs

(Contract NAS1-17099)

(NASA-CR-174277; NAS 1.26:174277) Avail: NTIS HC A03/MF A01 CSCL 20A

The use of an Apple II+ microcomputer to collect data during the operation of the 7 inch Mach Seven Tunnel is discussed. A method by which the contamination of liquid oxygen is monitored with sound speed techniques is investigated. The electrical equivalent of a transducer bonded to a high pressure fill plug is studied. The three areas are briefly explained and data gathered for each area are presented. B.G.

N85-16590*# Aeronautical Research Associates of Princeton, Inc., N. J.

ANALYSIS OF THE SURFACE LOAD AND RADIATED SOUND OF A VIBRATING AIRFOIL WITH APPLICATION TO THE EXPERIMENT OF BROOKS Final Report

J. E. YATES Washington NASA Jan. 1984 143 p refs

(Contract NAS1-17003)

(NASA-CR-3864; NAS 1.26:3864; ARAP-508) Avail: NTIS HC A07/MF A01 CSCL 20A

A method is developed for calculating the surface load and radiated sound from a vibrating surface in a compressible viscous fluid. The method is applied to a thin two-dimensional elliptic cross-section. For large values of the viscous diffusion parameter, the surface load tends to an elliptic distribution in agreement with the results of inviscid theory when edge pressure continuity is enforced. For thin surfaces, the surface load is insensitive to variations in the thickness ratio. A three-dimensional spectral technique is developed to calculate the inviscid surface load and radiated sound from a thin vibrating airfoil. The inviscid theory predicts the correct form of the far field sound pressure and its phase. The actual levels are somewhat sensitive to the choice of theoretical spanwise surface pressure mode but are in better agreement with the experiment than the surface pressure. The comparison of theoretical and experimental surface pressure indicates that the viscous theory, used to validate the inviscid theory, is either inadequate or there is a source of experimental error. R.S.F.

N85-16593# Federal Aviation Administration, Washington, D.C. Office of Environment and Energy.

HELICOPTER NOISE SURVEY PERFORMED AT LAS VEGAS, NEVADA, 19-21 JANUARY, 1984

S. R. ALBERSHEIM 1984 49 p

(AD-A147392; FAA/EE-84-15) Avail: NTIS HC A03/MF A01 CSCL 20A

The FAA conducted a noise measurement survey of helicopter operations at Las Vegas during the Annual Helicopter Association International Convention. The survey was performed during the period of January 19-21, 1984. The purpose of this noise survey was to obtain additional noise data for a number of different helicopter models during normal operations in an urban environment. This survey was the first test program which measured sideline noise levels beyond 500 feet. The data collected are classified as survey type data, since the data obtained were from target of opportunity as apposed to controlled test data. GRA

N85-16595# Federal Aviation Administration, Washington, D.C. Office of Environment and Energy.

NOISE MEASUREMENT FLIGHT TEST: DATA-ANALYSES AEROSPATIALE AS-355F TWINSTAR HELICOPTER

J. S. NEWMAN, E. J. RICKLEY, K. R. BEATTIE, and T. L. BLAND Aug. 1984 101 p

(AD-A147497; AD-F300490; DOT/FAA/EE-84-04) Avail: NTIS HC A06/MF A01 CSCL 20A

This report documents the results of a Federal Aviation Administration (FAA) noise measurement flight test program with the TwinStar twin-jet helicopter. The report contains documentary sections describing the acoustical characteristics of the subject helicopter and provides analyses and discussions addressing topics ranging from acoustical propagation to environmental impact of helicopter noise. This test program was designed to address a series of objectives including: (1) acquisition of acoustical data for use in assessing helicopter environmental impact, (2) documentation of directivity characteristics for static operation of helicopters, (3) establishment of ground-to-ground and air-to-ground acoustical propagation relationships for helicopters, (4) determination of noise event duration influences on energy dose acoustical metrics, (5) examination of the differences between noise measured by a surface mounted microphone and a microphone mounted at a height of four feet (1.2 meters), and (6) documentation of noise levels acquired using international helicopter noise certification test procedures. GRA

N85-17667*# Cleveland State Univ., Ohio.

INVESTIGATION ON EXPERIMENTAL TECHNIQUES TO DETECT, LOCATE AND QUANTIFY GEAR NOISE IN HELICOPTER TRANSMISSIONS Final Report

P. M. FLANAGAN and W. J. ATHERTON Washington NASA Jan. 1985 101 p refs Original contains color illustrations

(Contract NAG3-315)

(NASA-CR-3847; E-2294; NAS 1.26:3847) Avail: NTIS HC A06/MF A01 CSCL 20A

A robotic system to automate the detection, location, and quantification of gear noise using acoustic intensity measurement techniques has been successfully developed. Major system components fabricated under this grant include an instrumentation robot arm, a robot digital control unit and system software. A commercial, desktop computer, spectrum analyzer and two microphone probe complete the equipment required for the Robotic Acoustic Intensity Measurement System (RAIMS). Large-scale acoustic studies of gear noise in helicopter transmissions cannot be performed accurately and reliably using presently available instrumentation and techniques. Operator safety is a major concern in certain gear noise studies due to the operating environment. The man-hours needed to document a noise field in situ is another shortcoming of present techniques. RAIMS was designed to reduce the labor and hazard in collecting data and to improve the accuracy and repeatability of characterizing the acoustic field by automating the measurement process. Using RAIMS a system operator can remotely control the instrumentation robot to scan surface areas and volumes generating acoustic intensity information using the two microphone technique. Acoustic intensity studies requiring hours of scan time can be performed automatically without operator assistance. During a scan sequence, the acoustic intensity probe is positioned by the robot and acoustic intensity data is collected, processed, and stored.

N85-17668*# Virginia Polytechnic Inst. and State Univ., Blacksburg.

AN IMPROVED SOURCE MODEL FOR AIRCRAFT INTERIOR NOISE STUDIES

J. R. MAHAN and C. R. FULLER Jan. 1985 30 p refs

(Contract NAG1-493)

(NASA-CR-172517; NAS 1.26:172517) Avail: NTIS HC A03/MF A01 CSCL 20A

There is concern that advanced turboprop engines currently being developed may produce excessive aircraft cabin noise levels. This concern has stimulated renewed interest in developing aircraft interior noise reduction methods that do not significantly increase

take-off weight. An existing analytical model for noise transmission into aircraft cabins was utilized to investigate the behavior of an improved propeller source model for use in aircraft interior noise studies. The new source model, a virtually rotating dipole, is shown to adequately match measured fuselage sound pressure distributions, including the correct phase relationships, for published data. The virtually rotating dipole is used to study the sensitivity of synchrophasing effectiveness to the fuselage sound pressure trace velocity distribution. Results of calculations are presented which reveal the importance of correctly modeling the surface pressure phase relations in synchrophasing and other aircraft interior noise studies. R.S.F.

N85-17669# Federal Aviation Administration, Washington, D.C.
TEST OF DISPERSAL OF TURBOJET AIRCRAFT DEPARTURE TRACKS AT WASHINGTON NATIONAL AIRPORT (1983-84), VOLUME 1 REPORT Summary Report, 24 Oct. 1983 - 7 Jan. 1984

Oct. 1984 106 p 2 Vol.

(AD-A148111) Avail: NTIS HC A06/MF A01 CSCL 20A

This report is Volume 1 of a two-volume set describing the analysis of aircraft noise before, during and after the test of the so-called Scatter Plan, a dispersal of flight tracks for turbojet aircraft departing from Washington National Airport. The test, conducted by the Federal Aviation Administration (FAA) at the request of the Metropolitan Washington Council of Governments, took place from October 24, 1983, through January 7, 1984. Volume 1 presents analysis of data collected during the test. Volume 2, the Technical Appendix, consists of a compilation of field sheets, survey forms, and details of the field noise measurement program and the community attitudinal survey. The purpose of this report is to present the data collected during the test for the information of and interpretation by the interested public. The report does not include conclusions or recommendations on maintaining or changing the flight paths at Washington National Airport. GRA

N85-17670# Federal Aviation Administration, Washington, D.C.
 Office of Environment and Energy.

NOISE MEASUREMENT FLIGHT TEST FOR BOEING VERTOL 234/CH 47-D HELICOPTER: DATA/ANALYSES

J. S. NEWMAN, T. L. BLAND, and K. R. BEATTIE Sep. 1984 195 p

(AD-A148172; FAA/EE-84-7) Avail: NTIS HC A09/MF A01 CSCL 20A

This report documents the results of a Federal Aviation Administration (FAA) noise measurement flight test program with the Boeing-Vertol CH-47D helicopter. The report contains documentary sections describing the acoustical characteristics of the subject helicopter and provides analyses and discussions addressing topics ranging from acoustical propagation to environmental impact of helicopter noise. This test program was designed to address a series of objectives including: (1) acquisition of acoustical data for use in assessing heliport environment impact, (2) documentation of directivity characteristics for static operations of helicopters, (3) establishment of ground-to-ground and air-to-ground acoustical propagation relationships for helicopters, (4) determination of noise event duration influences on energy dose acoustical metrics, (5) examination of the differences between noise measured by a surface mounted microphone and a microphone mounted at a height of four feet (1.2 meters), and (6) documentation of noise levels acquired using international helicopter noise certification test procedures. GRA

N85-17672# Federal Aviation Administration, Washington, D.C.
 Office of Environment and Energy.

NOISE MEASUREMENT FLIGHT TEST: DATA-ANALYSES AEROSPATIALE AS 350D ASTAR HELICOPTER

J. S. NEWMAN, E. J. RICKLEY, K. R. BEATTIE, and T. L. BLAND Sep. 1984 175 p

(AD-A148496; FAA/EE-84-05) Avail: NTIS HC A08/MF A01 CSCL 20A

This report documents the results of a Federal Aviation Administration (FAA) noise measurement flight test program with

the AStar helicopter. The report contains documentary sections describing the acoustical characteristics of the subject helicopter and provides analyses and discussions addressing topics ranging from acoustical propagation to environmental impact of helicopter noise. This program was designed to address a series of objectives including: (1) acquisition of acoustical data for use in assessing heliport environmental impact, (2) documentation of directivity characteristics for static operation of helicopters, (3) establishment of ground-to-ground and air-to-ground acoustical propagation relationships for helicopters, (4) determination of noise event duration influences on energy dose acoustical metrics, (5) examination of the differences between noise measured by a surface mounted microphone and a microphone mounted at a height of four feet (1.2 meters), and (6) documentation of noise levels acquired using international helicopter noise certification test procedures. GRA

N85-17673# Federal Aviation Administration, Washington, D.C.
 Office of Environment and Energy.

NOISE MEASUREMENT FLIGHT TEST: DATA-ANALYSES, SIKORSKY S-76A HELICOPTER

J. S. NEWMAN, E. J. RICKLEY, T. L. BLAND, and K. R. BEATTIE Sep. 1984 190 p

(AD-A148525; FAA/EE-84-6) Avail: NTIS HC A09/MF A01 CSCL 17A

This report documents the results of a FAA noise measurement flight test program with the Sikorsky S-76 helicopter. It contains documentary sections describing the acoustical characteristics of the subject helicopter and provides analyses and discussions addressing topics ranging from acoustic propagation to environmental impact of helicopter noise. This report is the sixth in a series of seven documenting the FAA helicopter noise measurement program conducted at Dulles International Airport during the summer of 1983. The S-76 test program involved the acquisition of detailed acoustic, position and meteorological data. This test program was designed to address a series of objectives including: (1) acquisition of acoustic data for use in assessing heliport environmental impact; (2) documentation of directivity characteristics for static operation of helicopters; (3) establishment of ground-to-ground and air-to-ground acoustic propagation relationships for helicopters; (4) determination of noise event duration influences on energy dose acoustical metrics; (5) examination of the differences between noise measured by a surface-mounted microphone and a microphone mounted at a height of four feet; and (6) documentation of noise levels acquired using international helicopter noise certification test procedures. GRA

N85-17677# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Abt. Technische Akustik.

AEROACOUSTICS AT THE DFVLR BRUNSWICK RESEARCH CENTER: A SURVEY ON RECENT AND CURRENT ACTIVITIES

H. HELLER Aug. 1984 83 p refs Presented at 9th AAAF/GALF Colloq. d'Acoust. Aeron., Compiègne, France, 14-16 Nov. 1984 (DFVLR-MITT-84-14) Avail: NTIS HC A05/MF A01; DFVLR, Cologne DM 23.50

Basic and applied research and development projects pertaining to the noise of propeller driven planes and helicopters, to aeroacoustic specifics of wind tunnels, to airport noise and blast barriers, and to aerodynamically induced automobile noise are discussed. Planning of aeroacoustic projects is presented, and cooperation in national and international research and scientific committees is treated. Author (ESA)

SOCIAL SCIENCES

Includes social sciences (general); administration and management; documentation and information science; economics and cost analysis; law and political science; and urban technology and transportation.

A85-19826

THE DIVISION OF TASKS IN MODERN AIR TRANSPORT AND ITS EFFECT ON THE LIABILITY OF THE AIR CARRIER - THE CONCEPT 'AGENTS' IN THE SO-CALLED WARSAW CONVENTION [DIE ARBEITSTEILIGKEIT IM MODERNEN LUFTVERKEHR UND IHR EINFLUSS AUF DIE HAFTUNG DES LUFTFRACHTFUEHRERS - DER BEGRIFF 'LEUTE' IM SOG. WARSCHAUER ABKOMMEN]

R. SCHMID Frankfurt, Universitaet, Fachbereich Rechtswissenschaft, Doktor Dissertation, 1983, 286 p. In German. refs

The legal definition of air-carrier liability in paragraphs 17-20 of the Warsaw Convention of 1929 is investigated, with a focus on the French term 'preposes' in paragraph 20. Linguistic, comparative, historical, and logical analyses of the term as it has been incorporated into the legal codes of the signatories and in relevant passages of laws governing sea, rail, and road transportation are undertaken; and it is shown that both narrow interpretations (preposes = employees of the carrier) and broad interpretations (preposes = employees and independent contractors) have been or are currently in force. It is argued that the broad definition is correct but that the carrier is liable only for the acts or omissions of persons or firms performing directly-air-carriage-related functions. Legal language clarifying this relationship is proposed for eventual insertion in the Convention, and the effect of the present language, as interpreted, on each individual type of employee or contractor commonly involved in modern air transport is evaluated. T.K.

A85-21840#

SKIRT MATERIAL EFFECTS ON AIR CUSHION DYNAMIC HEAVE STABILITY

T. A. GRAHAM, P. A. SULLIVAN (Toronto, University, Downsview, Ontario, Canada), and M. J. HINCHEY (Newfoundland, Memorial University, St. John's; Toronto, University, Downsview, Ontario, Canada) Journal of Aircraft (ISSN 0021-8669), vol. 22, Feb. 1985, p. 101-108. Research supported by the Transportation Development Centre of Canada; Natural Sciences and Engineering Research Council of Canada. Previously cited in issue 05, p. 692, Accession no. A83-16675. refs
(Contract NSERC-AS-3378)

A85-21942

REPORT FROM THE UNITED STATES OF AMERICA

J. E. MURDOCK, III (FAA, Washington, DC) Zeitschrift fuer Luft- und Weltraumrecht (ISSN 0340-8329), vol. 33, Dec. 1984, p. 298-304.

Legal aspects of airport planning, construction, and expansion in the U.S. are surveyed. It is pointed out that the impetus for new airport construction or the enlargement of existing facilities comes from local or state governments or from citizen groups rather than from the Federal government, which enters the process (through the FAA) when funds from the Airport Improvement Program are applied for. Opponents mainly use the provisions of the National Environmental Policy Act of 1969 or its state or local analogs, challenging the sponsor or the FAA in Federal or state courts on the grounds that the detrimental environmental impact of the planned construction is not justified by the expected economic or traffic-flow benefits. Such actions have been effective in delaying or preventing construction, especially of new large-capacity commercial-carrier airports, so that most new capacity must come from expansion. Nevertheless, it is argued that local initiative and eventual local resolution of such conflicts

is as effective an approach as centrally imposed planning. Data on the local economic benefits of airports and the timetable of a typical planning effort are provided in tables. T.K.

A85-21943

REPORT FROM THE UNITED KINGDOM

R. L. EVERITT (British Airports Authority, Gatwick, Sussex, England) Zeitschrift fuer Luft- und Weltraumrecht (ISSN 0340-8329), vol. 33, Dec. 1984, p. 305-316.

The legal procedures required for the planning and implementation of airport construction or expansion in the UK are reviewed, with a focus on recent major terminal developments undertaken at the three London airports by the British Airports Authority. The steps involved in obtaining a Development Order are characterized, including the Planning Application, preinquiry procedures, the public inquiry (justification of the development and evaluation of its impact), the role of the presiding Inspector, the postinquiry report to the Government Ministers and their ruling, implementation of the decision by local planning authorities, and court challenges to the decision of the Ministers by affected parties (on grounds of procedural errors or unreasonableness). It is found that the procedures are often very time-consuming, and that opponents are often successful in delaying construction or forcing the inclusion of environmental provisions such as curfews or noise barriers. T.K.

A85-21944

CONSTRUCTION AND EXTENSION OF AIRPORTS - LEGAL PROCEDURE AND PRACTICE IN CANADA

J.-L. MAGDELENAT (McGill University, Montreal, Canada) Zeitschrift fuer Luft- und Weltraumrecht (ISSN 0340-8329), vol. 33, Dec. 1984, p. 317-327. refs

A85-21945

CREATION AND EXTENSION OF AIRPORTS - PROCEDURES AND PRACTICE [CREATION ET EXTENSION D'AEROPORTS - PROCEDURES ET PRATIQUE]

J. DUTHEIL DE LA ROCHERE (Paris V, Universite, Paris, France) Zeitschrift fuer Luft- und Weltraumrecht (ISSN 0340-8329), vol. 33, Dec. 1984, p. 329-342. In French. refs

The legal procedures involved in the planning and construction of new airports or the expansion of existing airports in France are surveyed. Airports are classified according to technical criteria (following ICAO Annex 14), usage (private, public, or state), and sponsorship (state or nonstate); and the procedures required for the various classes are characterized. National and regional planning efforts begun in 1973 are shown to be in a waiting phase, since the growth of air traffic (by about 10 percent/yr) in the 1970s has slowed; realization of the plans in the 1990s is predicted. Problems involved in planning airport construction projects are discussed in detail, including land acquisition, safety, and noise, and a trend toward more transparent and publicly accessible planning and approval procedures is identified. T.K.

A85-21946

REPORT FROM SWEDEN

N. EDSTROM (Luftfartsverket, Stockholm, Sweden) Zeitschrift fuer Luft- und Weltraumrecht (ISSN 0340-8329), vol. 33, Dec. 1984, p. 343-358.

Legislation and legal procedures governing the planning and construction of airports and extensions to existing airports in Sweden are surveyed. Consideration is given to the Aviation Act of 1957 and possible conflicts between safety and environmental concerns arising under it, the National Building Act of 1947, the role of the Board of Civil Aviation (BCA) in operating 19 of the 220 Swedish airports and regulating the rest, the Environmental Protection Act of 1969, and proposals for environmental legislation in 1984. The formal procedures are shown to vary according to the initiating party (a private organization or the BCA) and to allow ample access to all concerned parties at open hearings, and the degree of cooperation in their implementation so far is judged as satisfactory. The findings of the Traffic Noise Committee of

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Parliament on aircraft noise (1975) are summarized in an appendix. T.K.

A85-21947

CONSTRUCTION AND EXTENSION OF AIRPORTS - NATIONAL REPORT ON SWITZERLAND

W. GULDIMANN Zeitschrift fuer Luft- und Weltraumrecht (ISSN 0340-8329), vol. 33, Dec. 1984, p. 359-369; Discussion, p. 370, 371.

A85-21948

REPORT FROM JAPAN

T. SAKAMOTO (Japan Air Lines Co., Ltd., Tokyo, Japan) Zeitschrift fuer Luft- und Weltraumrecht (ISSN 0340-8329), vol. 33, Dec. 1984, p. 373-383. refs

Legal aspects of the planning and construction of airports and airport extensions in Japan are reviewed. Civil airports in Japan are operated exclusively under the authority of the Transport Ministry or local governments (except for the facility operated by the New Tokyo International Airport Authority), and improvements are carried out under a series of five-year plans (currently for 1981-1985). The application procedure, public notification requirements, airport-establishment and airport-expansion criteria, the public hearing process, and the rights of affected parties to challenge the decision of the Minister in court are characterized. The implications of the Supreme Court decision of 1981 (involving noise at Osaka airport) with regard to suspensions of takeoffs and landings, compensation for past and future damages, and assumption of risk by persons moving to the airport vicinity are discussed; and it is pointed out that the Osaka case, the only such case to reach the Supreme Court, was in litigation for more than 12 years. T.K.

A85-21949

NATIONAL REPORT - THE FEDERAL REPUBLIC OF GERMANY [LAENDERBERICHT - BUNDESREPUBLIK DEUTSCHLAND]

H. ACHTNICH (Arbeitsgemeinschaft Deutscher Verkehrsflughafen, Stuttgart, West Germany) Zeitschrift fuer Luft- und Weltraumrecht (ISSN 0340-8329), vol. 33, Dec. 1984, p. 384-401; Discussion, p. 402, 403. In German.

The legal procedures involved in approving and implementing plans for airport construction or expansion in the FRG are reviewed. The FRG airport system is briefly characterized; the ongoing improvements are listed; and the two-stage formal process by which proposals are evaluated and approved (under air law and under the general planning law, at the level of the federal states of the FRG, but with review and approval by the federal Transportation Minister) is examined. Consideration is given to the broad range of parties admitted to the process, the criteria employed in the decision, and the jurisdictions available to opponents to contest the decision of the state transport ministry. The long duration of the approval process and subsequent litigation is illustrated with a timetable listing governmental and court decisions on the extension of Frankfurt airport over the period 1965-1984. T.K.

N85-16667# RAND Corp., Santa Monica, Calif.

MANAGING RECOVERABLE AIRCRAFT COMPONENTS IN THE PPB AND RELATED PROCESSES: EXECUTIVE SUMMARY Interim Report

J. H. BIGELOW Jun. 1984 56 p

(Contract MDA903-81-C-0381)

(AD-A146806; RAND/R-3093-MIL) Avail: NTIS HC A04/MF A01 CSCL 15E

ORACLE (Oversight of Resources And Capability for Logistics Effectiveness) explores how the requirements to buy and repair aircraft components are related to the peacetime and planned wartime availability and flying activity of aircraft. It operates by producing a summary database from the Air Force's DO41 (Recoverable Consumption Item Requirements Computation System), a database from which one can estimate almost instantaneously and with remarkably little error how the complete DO41 computation, involving 150,000 separate components, would

have responded to a change in peacetime or wartime flying activity, aircraft availability, and a variety of other quantities. We feel that its primary use will be in the PPB process, to estimate budgetary consequences of changes in flying programs and the like. But it could also be used to help allocate funds during execution.

Author (GRA)

N85-16682# General Accounting Office, Washington, D. C. National Security and International Affairs Div.

THE AIR FORCE CAN IMPROVE ITS FORECASTS OF AIRCRAFT SPARE PARTS REQUIREMENTS

19 Nov. 1984 27 p

(AD-A147911; GAO/NSIAD-85-2) Avail: NTIS HC A03/MF A01 CSCL 15E

The Air Force forecasts its aircraft spare parts requirements by calculating a ratio of future flying hours to past flying hours for the aircraft using a specific part and then applying this ratio to the historical demand for the part. GAO found that the process resulted in overstated estimates for some parts and understated estimates for others because: (1) The computer file which identifies the aircraft on which the individual parts are used contained inaccurate data. (2) The requirements were not computed on the basis of all the unique combinations of aircraft which use each part. (3) The time period used in calculating the ratios does not correspond to the time needed to obtain the part. GAO makes recommendations designed to correct these problems and improve the Air Force's forecasting process for aircraft spare parts. GRA

N85-16685# RAND Corp., Santa Monica, Calif.

ESTIMATING WARTIME SUPPORT RESOURCE REQUIREMENTS. STATISTICAL AND RELATED POLICY ISSUES Interim Report

L. B. EMBRY Jul. 1984 111 p

(Contract F49620-82-C-0018)

(AD-A147923; RAND/N-2163-AF) Avail: NTIS HC A06/MF A01 CSCL 15E

The Air Force spends several billion dollars annually to procure the spare parts and other resources need to support modern aircraft weapon systems. A large fraction of this investment is used to obtain assets for support of wartime operations. The assumptions used to project peacetime experience to wartime activity levels have important resource implications, but little has been done to test them empirically. Peacetime operational experiments, coupled with engineering projections of wartime failure rates, could be used to test these assumptions and provide an improved basis for resource requirements computations. This note addresses statistical and policy issues central to improving estimates of wartime support resource requirements. It uses the current problem of establishing the level of investment in spare engines for the C-5 aircraft to elucidate a number of these issues. The results should be of interest to policymakers concerned with logistics resource allocation, operational commanders whose wartime capabilities are affected by statistical assumptions and related policy decisions, and personnel responsible for producing requirements estimates. Originator-supplied keywords include: spare parts, failure, logistics planning, military aircraft and aircraft engines. GRA

N85-17732# Louisiana State Univ., Baton Rouge. Dept. of Quantitative Business Analysis.

PRODUCTION RATE VARIATIONS COST MODELS Final Report, 1 Jun. - 14 Aug. 1984

T. R. GULLEDGE, JR. 14 Aug. 1984 17 p

(Contract F49620-82-C-0035)

(AD-A147708) Avail: NTIS HC A02/MF A01 CSCL 14A

This research examines a model that may be used to estimate the cost impact of production rate changes on a timely and real world basis. Part 1 analyzes current models that are being implemented by Air Force Systems Command, and demonstrates that these models are deficient in their theoretical definition and empirical construction. Part 2 presents current status of the development of a more realistic rate variations model for the F-16 aircraft program. GRA

N85-17740*# National Aeronautics and Space Administration.
Langley Research Center, Hampton, Va.

**SCIENTIFIC AND TECHNICAL INFORMATION OUTPUT OF THE
LANGLEY RESEARCH CENTER FOR CALENDAR YEAR 1984**

Jan. 1985 247 p

(NASA-TM-86336; NAS 1.15:86336) Avail: NTIS HC A11/MF
A01 CSCL 05B

The scientific and technical information that the Langley Research Center produced during the calendar year 1984 is compiled. Approximately 1650 citations are included comprising formal reports, quick-release technical memorandums, contractor reports, journal articles and other publications, meeting presentations, technical talks, computer programs, tech briefs, and patents. M.G.

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GENERAL

N85-17928*# National Aeronautics and Space Administration.
Lewis Research Center, Cleveland, Ohio.

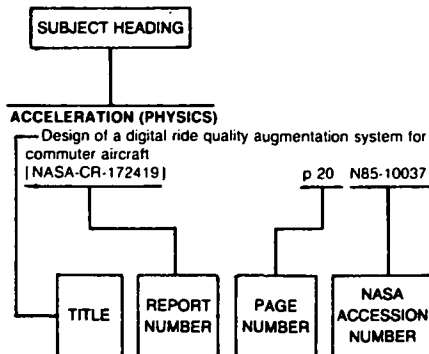
**RESEARCH AND TECHNOLOGY HIGHLIGHTS OF THE LEWIS
RESEARCH CENTER Annual Report, 1984**

1984 52 p

(NASA-TM-86899; NAS 1.15:86899) Avail: NTIS HC A04/MF
A01 CSCL 05A

Highlights of research accomplishments of the Lewis Research Center for fiscal year 1984 are presented. The report is divided into four major sections covering aeronautics, space communications, space technology, and materials and structures. Six articles on energy are included in the space technology section. B.W.

Typical Subject Index Listing



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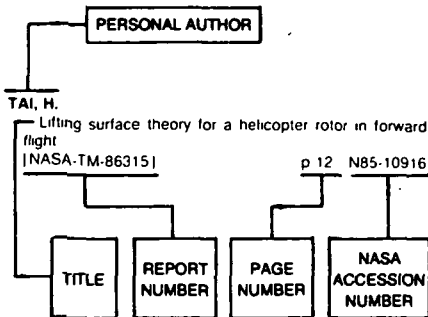
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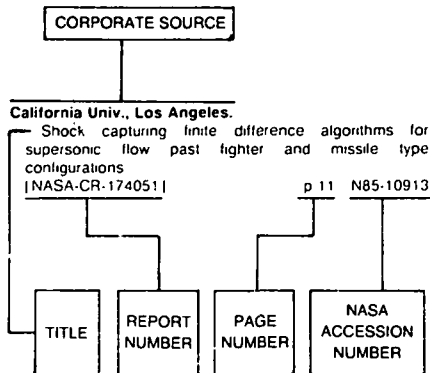
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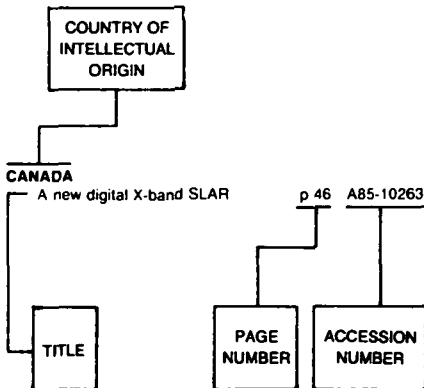
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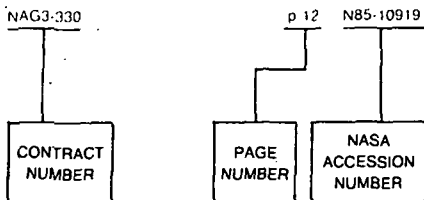
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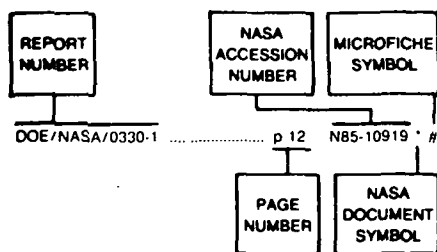
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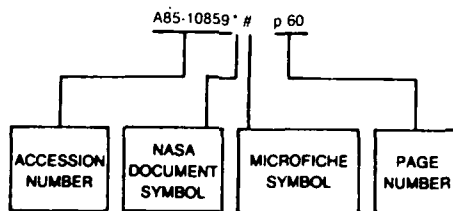
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